Mathematics Problem-Solving Ability Based on Learning Style of Junior High School

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ABSTRACT
This study is exploratory research aimed to find out the ability to solve HOTS (Higher Order Thinking Skill) questions of students who have visual (SV), auditory (SA), and kinesthetic (SK) learning styles of grade 8th Junior High School 33 Makassar. The data collection instruments used in this study were HOTS questions of type C4 (analysis) and C5 (evaluation) based on the Revised Bloom's Taxonomy. Furthermore, to obtain credible data, method triangulation was applied by using written tests and doing interviews. The research subjects consisted of 3 students in which each of them had a different learning style. The results of the study show that: 1) student with visual learning style does not have any difficulty in understanding the problems, planning the solutions, solving the problems, and reviewing the solutions; 2) student with auditory learning style does not have any difficulty in understanding the problems and reviewing the solutions, but has difficulties in planning the solutions and solving the problems; 3) student with kinesthetic learning style does not have difficulties in reviewing the solutions but has difficulties in understanding the problems, planning the solutions, and solving the problems.

Keywords: *HOTS, Learning Style, Polya's Heuristic Problem Solving.*

1. INTRODUCTION

People need Higher Order Thinking Skills (HOTS) to face challenges in twenty-first-century life, particularly the industrial revolution 4.0 [1]. The skills account for logical thinking, analysis, evaluation, and creation. Students should be able to achieve them through mathematics education. The teacher should make students learn in accordance with their own sensory preferences.

Utami & Wutsqa [2] state at least two international studies which are important for reflecting the quality of Indonesian education, that is, Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). The results of PISA 2015 indicate that the mathematics score of Indonesian students is in the 63rd position of 70 participating countries. Meanwhile, TIMSS 2011 means that Indonesian students are in the 38th of 42 participating countries. This shows the necessity for improving students' mathematics ability, particularly the ability to solve problems.

In solving problems, especially higher-order thinking skill problems, students will use a variety of strategies. Problem-solving strategy is, in fact, mainly influenced by several factors. One of them is learning style. Learning style impacts an individual learning process so that it becomes a consideration material in designing instruction. There are three learning modalities, namely visual, auditory and kinesthetic [3].

Implementation of a convenient learning style will improve the learning process. It is also stressed that conformity between the learning model and learning style will result in a productive learning situation in class. Some research results show that there is a significant influence of learning style on learning achievement. Kolb & Kolb also report that students' learning achievement concerning their learning style is better than not [4]. Based on the outline, we can say that learning style influences learning style towards learning achievement. Moreover, in the twenty-first century, people are

required to have higher-order thinking. Thus students should know based on their learning style.

2. LITERATURE REVIEW

Higher-Order Thinking Skills constitute students' thinking process at the higher cognitive level, which evolved from various concepts, cognitive methods, and learning taxonomy like problem-solving, Bloom taxonomy, and taxonomy of learning, teaching, and assessment [5]. The higher-order thinking skill comprises solving the problem, thinking creatively and critically, stating argumentation, and making decisions. According to King, higher-order thinking skill includes critical, logical, reflective, metacognitive, and creative thinking, whereas Newman & Wehlage state that through higher-order thinking, students will be able to differ their ideas obviously, state argumentation well, solve the problem, construct an explanation, hypothesize and understand complex things to become more clear [6]. According to Vui, higher-order thinking skills will occur when someone relates new information to the information existing in their mind. They describe, re-process, and develop it to achieve a goal or solve a difficult state [7]. The main aim of the higher-order thinking skill is on how to enhance or upgrade students' thinking ability to the higher level, especially related to the ability to think critically in accepting various kinds of information, creative thinking in solving a problem by using information or knowledge they have, along with deciding complex situations [5].

Due to the development in education theory, Krathwohl and cognitivist improved the Bloom taxonomy to adapt with the advance over time. The improvement was then published in 2001 so-called Revised Bloom's Taxonomy. The revision is just in the cognitive domain by using the verb.

Table 1. Example of Action Verbs in Each Cognitive Level

Cognitive Levels	**Example of Action Verbs**
C1: Remembering	tell, show, recall, write, label.
C2: Understanding	compare, explain, translate, summarize, classify
C3: Applying	experiment with, develop, organize, solve, make use of
C4: Analyzing	integrate, demonstrate, differentiate, analyze, inquiry
C5: Evaluating	assess, test, judge, monitor, critique, coordinate
C6: Creating	construct, formulate, produce, generate, design

Source: [8]

C1, C2, and C3 are in the Lower Order Thinking Skills (LOTS). Meanwhile, C4, C5, and C6 are in the Higher Order Thinking Skills (HOTS). According to Anderson ([9]), this change is undertaken by providing a new version to the cognitive domain: the dimension of cognitive process and cognitive knowledge. Meanwhile, learning style is a relatively constant and consistent way of catching stimulus or information, remembering, thinking, and solving problems. It can be stated that learning style is one of the students' characteristics. Learning style and quality have a close relationship and influence the learning process to attain the learning goal [4]. Fitriyah [10] reported her research result showing that learning style impacts significantly on learning achievement.

According to DePorter [11], visual learning styles have some characteristics, like being organized, paying attention to all things, taking care of performance, remembering through the picture, preferring reading, and comprehensively requiring description and goal. Meanwhile, students with learning styles as auditory have some characteristics, like their attention is easy to go around; talking rhythmically; learning by listening, moving lips, or reading out loud; dialogue internally and externally. In contrast, students with learning styles as kinesthetic have some characteristics, like touching people frequently, standing close to each other, moving around when interacting with others, learning by doing, appointing at writing while reading, remembering while walking, and looking at.

Four steps can be used in problem-solving, according to Polya [12], that is, understanding the problem, devising a plan, carrying out the plan, and looking back.

Akbar [3] reported his research entitled, "analysis of problem-solving error in the mathematical problem with higher-order thinking skill viewed from learning style of Grade X students of Senior High School

State 3 Makassar". The research results are as the following.

First, understanding the problem. Subject SK tended to make factual errors. In this case, he managed not to make letting or writing notation in modeling the given situation. This was because the subject with a kinesthetic learning style could not abstract the data existing in the problem.

Second, carrying out the plan. Subject SV tended to make operational errors. In this case, subject SV shortened his solution steps. It was because he was not computing thoroughly. Meanwhile, Subject SA tended to make operational errors. It meant that he made mistakes in the computation process shown in his solution of a mathematical model. It was because he was not computing thoroughly.

In comparison, Subject SK tended to make operational errors. In this case, Subject SK made mistakes in the computation process shown in his solution of a mathematical model. It was because of the lack of students' understanding of a linear equation system with two variables.

Third, looking back. Subject SA tended to make operational errors. In this case, he did not write down the final answer based on the data given in the problem. It was because of the lack of students' understanding of the linear equation system with two variables. Meanwhile, Subject SK tended to make operational errors as well. In this case, Subject SK re-checked the solution obtained but did not use systematic steps and did not write down the final answer based on the data given in the problem. It was because of the lack of students' understanding of a linear equation system with two variables.

3. RESEARCH METHODS

This research was explorative research with a descriptively qualitative approach. The explorative analysis was used because researchers would like to dig the students ' ability to carry out HOTS problems viewed from their learning styles, i.e., visual, auditory, and kinesthetic. Whereas descriptively qualitative approach was conducted to get qualitative data such as written or oral words observed from the research subjects. The data obtained from all the research subjects with different learning styles were then described. This research aimed at investigating and representing the students' learning styles when solving problems with higher-order thinking skills.

The choice of the research subject candidates was administered in Grade VIII-A, consisting of 36 students. They were provided with a pretest to select students to the next step so that those taking the subsequent test were those with good ability in mathematics. The trial was held on Tuesday, November 12, 2019, classically to all research subject candidates. The pretest results were selected 18 students with the highest scores and then provided a learning style questionnaire. The questionnaire was given to identify students with visual, auditory, and kinesthetic learning styles. The learning style questionnaire was undertaken on Monday, November 22, 2019, classically to all research subject candidates. Based on the learning style questionnaire results, it was obtained, 10 students were categorized as visual learning style, 2 students categorized as auditory learning style, 3 students classified as kinesthetic learning style, and 3 students categorized as mixed learning style or unification of two learning styles.

The selected subjects were then provided with a written test on the topic of direct and indirect proportions. The following two mathematics problem-solving questions were utilized in this research.

PROBLEM-SOLVING QUESTION 1
To run an online business, three people work together with different age levels. The three people are Husnul, Eki, and Udi. The age ratio of Husnul and Eki is 2 : 3, while the age ratio of Eki and Udi is 4: 5. If Husnul is now 16 years old, how old is Udi?
PROBLEM-SOLVING QUESTION 2
One unit of the house, if done by 20 people with relatively the same abilities and skills, will be completed in 20 days. A contractor works on the house by employing 15 people with the same capabilities and skills for 20 days. Since the house will be used with 15 days remaining, the contractor then deploys 30 workers with the same abilities and skills. Will the home be finished with the established target?

Once providing the research subjects with the above two questions as written tests, the researchers described their problem-solving process based on Polya’s heuristic. Information of the data obtained from the written test results would then be triangulated through interviews. The interview was conducted to get more information that could not be obtained through the written test from the research subjects.

4. RESULTS AND DISCUSSIONS

4.1. The Subject Type of Visual Learning Style (SV)

The student with visual learning style (SV) wrote his answer. It can be seen from Figure 1. It shows SV's answer sheet for question number 2. Within the indicator of the problem, SV simplifies the ratio of 15 people to 20 days, then multiplies it by a number that can give a product approaching the target as asked in question number 2. After that, he draws a conclusion based on what was obtained and asked in the question. He also attempts to carry out the problem based on the plan established in devising a plan, where he finds the working load of every person per day. Subsequently, drawing a conclusion based on the concept of indirect proportion. He re-explains with complete objects orally.

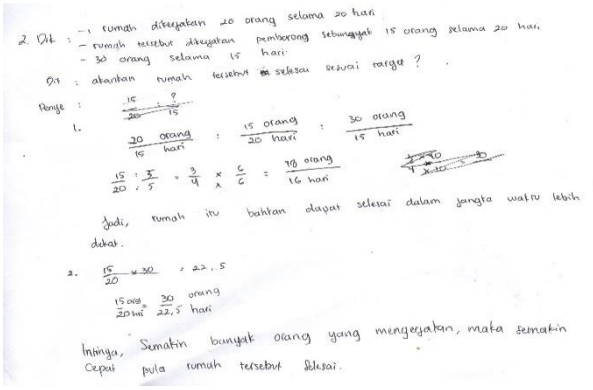

Figure 1. Excerpt of SV's Work

Transcript 1 is the outline of interview results with SV in the indicator of carrying out the problem. The outline of the interview results with SV in the indicator of carrying out the problem can be seen from the following interview result shows that SV is consistent with his answer. The interview result (I was still rather confused with this one. I do not understand the completion process well. In my mind, I would like first to find the number of workers who can complete the project per day, but I cannot do that. And then, after seeing it, I would like to associate it with 30 people per 15 days, whether it is appropriate or inappropriate) is in line with SV's work in his answer sheet (Figure 1). It is subsequently the interview result. "I think it is wrong. I want to find the number of workers per day, but I cannot do it. I do not know the way to find it. So, the essential thing to me is that more workers, faster the completion of building the house" indicating that SV does not obtain the expected result; so that he directly draws a conclusion based on the concept of indirect proportion, that is, more workers, faster the completion of building the house. In addition, he should draw a conclusion based on what is asked in the question. Thus it is obtained that SV encounters an obstacle in carrying out question number 2.

4.2. The Subject Type of Auditory Learning Style (SA)

The student with the auditory learning style wrote his answer. It can be seen from Figure 2.

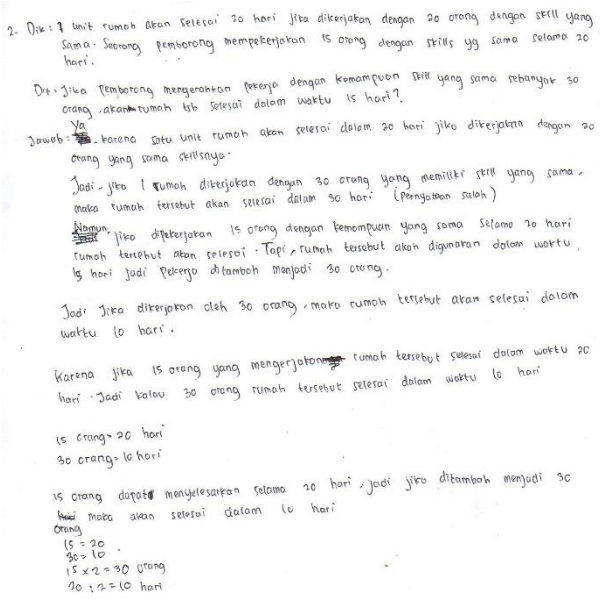

Figure 2. Excerpt of SA's Work

Figure 2 shows that SA carries out question number 2 without planning at all. He carries out using his logic which is not in line with what is given and asked. One of his mistakes is when he says that the house will be finished in 30 days. He is asked to make the computation for determining the number of days required to complete his work. Nevertheless, he does not do it. This shows that he is misunderstanding when solving the problem. In addition, he makes mistakes when concluding. His statement indicates that more people working on the house building project, faster its completion. While asked in question number 2, that is, will the house building project be completed in 15 days?

The outline of the interview results with SV in the indicator of carrying out the problem can be seen from the following interview result "The solution steps are based on the given question, but I do not refer only to the first sentence of the question. I refer to the second sentence of the question. So, 15 (workers) will automatically be 30 (workers) if multiplied by 2. Thus I need to divide it by 2 to obtain 10 days" Transcript 2 above indicates that SA explains the solution to the problem using the same

process shown in his answer sheet (Figure 2). He does not encounter problems in the step of carrying out the problem. He easily determines the steps that he must take to arrive at a final answer. However, he draws a conclusion based on the concept of indirect proportion in general.

4.3. The Subject Type of Kinesthetic Learning Style (SK)

The student with a kinesthetic learning style wrote his answer in the answer sheet. It can be seen from Figure 3.

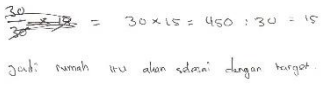

Figure 3. Excerpt of SK's Work

Figure 3 shows that SK makes a plan which is not in line with the procedure (Figure 3). It is because he multiplies 30 (the number of workers) by 15 (the number of days) and then divides the product by 30 (the number of workers). SK should find the remainder of the working load (how many days are required if one person is working). Here is which is divided by 30 people. It means that if the quotient is less than 15, then the work is on target. But if the quotient is more than 15, then the result is not on target.

The outline of the interview results with SK in the indicator of carrying out the problem can be seen from the following interview result "Owh, I make a mistake. 20 (the number of workers with relatively the same skill) multiplied by 20 (days) and then divided by 20 (workers with relatively the same skill). While this one (appointing to a statement: a contractor works on the house by deploying 15 people with relatively the same skill for 20 days). It means 15 (workers with relatively the same skill) multiplied by 20 (days) and then divided by 15 (workers with relatively the same skill)." This indicates that SK is consistent with his mistakes in answering the question, as shown in the answer sheet (Figure 3). SK makes mistakes in establishing the solution process to question number 2.

5. CONCLUDING REMARKS

Based on the research results above, it can be drawn concluding remarks as the following.

1. Description of a student's visual learning style (SV) ability to solve higher-order thinking skill problems.
   a. In the step of understanding the problem, SV can understand the intention of the problem and then write and explain all the things given and asked in it wholly and correctly.
   b. In devising a plan, SV changes are given and asked into a mathematical model as proportion. And then he is only able to explain it briefly and not in detail.
   c. In carrying out the plan, SV quickly determines the steps he must pass through to get the final answer. He quickly concludes appropriately. He explains the solution process shortly and does not demonstrate it step by step.
   d. Looking back, SV reviews his answer by re-reading the question and then reviewing his response. However, he is not convinced of his answer. Because he perceives the question utilizes a particular formula, he does not know precisely about it.
2. Description of a student's auditory learning style (SA) ability to solve higher-order thinking skill problems.
   a. In understanding the problem, SA easily writes the given and the asked thing in the question. He explains briefly the same process as he writes in the answer sheet.
   b. In the step of devising a plan, SA experiences difficulty in writing his answer symbolically. However, he can understand the given problem. He can communicate very well by using words that are appropriate and easy to understand. SA can classify the two questions given into direct or indirect proportion.
   c. In the step of carrying out the problem, SA can solve the problem by words. SA explains his solution fluently, using words that are easy to understand. This indicates that the masters the solution shown.
   d. In looking back, SA reviews his answer by re-reading the question well and then redoing it. If the answer is appropriate, then he submits his answer sheet to the examination supervisor. This makes him sure that his answer is correct.
3. Description of a student's kinesthetic learning style (SK) ability to solve higher-order thinking skill problems.

a. In the step of understanding the problem, SK encounters an obstacle in writing the given thing. He ignores to write the something given in the question. In comparison, he does not face an impediment to writing the thing asked in it. From the interview results, it is acquired that he does not encounter an obstacle in the indicator of understanding the problem. It is because he easily mentions the thing given and asks the question.

b. In devising a plan, SK's answer sheet seems to be hesitant in planning the solution repeatedly. He does not write all steps of the key to the given problem. He only thinks of it and then reports the results on the answer sheet. In the interview session, he explains the steps of his solution orally but does not write it at all.

c. In the step of carrying out the plan, SK does not write steps systematically. He thinks continuously and tries to find the answer on a rough copy paper, and then he writes his final result on his answer sheet. He also makes mistakes in carrying out the problem. He can write the conclusion correctly in line with the thing asked in the question. In the interview session, he indicated his ability to communicate well. He explains the solution steps. Nevertheless, he frequently changes his mind about which he chooses, whether choosing what he had written or thought when he was interviewed.

d. He reviews his answer by redoing the question to ensure that his previous answer is equal to that obtained when reviewing it. However, he is not convinced of his response. It is because he perceives that the question requires him to use a particular formula that he does not have. Meanwhile, he only uses his own logic to answer the question.

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