Students’ difficulties in mathematics learning with artisan character type in HOTS trigonometry test

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Abstract. HOTS is a real-life based assessment of everyday life, but in practice, the students are having trouble completing the HOTS issue. Learning difficulty is also influenced by artisan character type. The artist's subject finds patterns and relationships by scribbling on the answer sheet and using the knowledge he has. The artist's subject guesses by connecting the information from previous experience available. The artisan subject generalizes by using symbols. The artisan subject examines the validity of an argument by showing a supporting example. The instruments used are character type questionnaire, and HOTS test. This study aims to describe the difficulty of structured numbered heads mathematics learning model in students with artisan character, especially in solving HOTS in trigonometry material. This is descriptive qualitative research. The results show that students with artisan have a total of 2.02% difficulties in number fact skill, 13.1% in arithmetics skill, 34.34% in information skill, 27.27% in language skill, 23.23% in visual-spatial skill.

1. Introduction

Critical and creative thinking have a relation with the cognitive process dimension, according to Bloom revised taxonomy. Thus the use of the HOTS definition by referring to the top three cognitive process dimensions of Bloom's revised taxonomy (analyzing, evaluating, and creating) is more operational and represent the aspects of critical and creative thinking skills [1]. There are several reasons why Bloom's revised taxonomy is most relevant in determining HOTS indicators. First, in the world of education, indicators and learning objectives are formulated using operational verbs (KKO), which refers to Bloom's taxonomy (both original and revised). Second, educators in Indonesia are more familiar with the term Bloom taxonomy than critical thinking, creative, and so on. Third, there are still differences of opinion among experts related to indicators of critical and creative thinking skill. Based on that reason, the HOTS indicator is most appropriate and relevant to the educational context in Indonesia, which is referring to Bloom's revised taxonomy [2]. According to the data from the Program for International Student Assessment (PISA) test held by OECD in 2015, Indonesia's mathematics achievement is in 64th from 72 countries [3]. The same thing was also expressed by Conklin that the high-level thinking ability should be developed to meet the demand of the 21st century, which urge anyone to have competitive skills. HOTS itself train the students' high-level thinking ability [4]. Therefore, HOTS will help students to have a well developed competitive skill to face the 21st-century competition.

From the BSNP PAMER program which show the Senior High School National Examination data for academic year 2015/2016 in Tulungagung, it is known that the absorptive capacity of the students...
in mathematics was low. One of them was SMAN Kalidawir with trigonometry material as the lowest absorption strength, which only hit 33.56% [5]. Therefore, it can be concluded that students have learning difficulties in trigonometry material. This is supported by Siyepu (2015), which stated if many students are confused to use alternative solutions when facing the trigonometry problem [6]. Lack of understanding in trigonometry concepts will lead to some difficulties in the further learning process.

Furthermore, Siyepu stated that many students experienced difficulties both in procedural and conceptual. Many students experienced difficulties in interpreting the purpose of the problem and the calculation process. Also, based on research from Maharaj (2008), many students can understand the concept clearly on trigonometry material, and some of them have difficulties in using and understanding the use of algebraic notation in trigonometry [7]. Specifically, for example, errors found in trigonometric comparison material where students have a problem in describing the relationship from the angle and sides in a right-angled triangle. Many students also have difficulty in showing the multiplication of $\sin x \cdot \sin x$. Orhun argued that perhaps students did not pay attention to the addition, subtraction, multiplication, and division of trigonometric functions explanation when learning in junior high school [8].

From the informal interview, the researcher found that students are not accustomed to a mathematics problem formed in pictures. They feel difficult to translate the problem into mathematics sentence. They also stated that mathematics is irrelevant to their daily life problem. It means that they did not believe if mathematics is important. This abstract impression leads Indonesian students to face the mathematics as a very dangerous subject.

The learning model used also contributes to influencing learning. In this study, SNH (Structured Numbered Heads) learning model was used. This model was developed from NHT (Numbered Heads Together). SNH can eliminate the gaps between students who are knowledgeable and students who are low-knowledgeable, and each of them play an active role in the discussion. Thus, learning trigonometry with SNH model is expected to help students in developing visualization, critical thinking, intuition, perspective, problem-solving, conjecturing, deductive reasoning, logical argument, and proofing skills [9].

The mathematics learning difficulties may also be caused by a different character in each [10]. Keirsey divides personality into 4 types, i.e., guardian, artisan, rational, and idealist. Each character has its uniqueness. Keirsey illustrated the classification of personality types briefly, which are divided into two ways, namely observing and introspective. He classified a person who likes to observe as a sensing type and who likes to introspection as an intuitive type. Someone who belongs to the type of sensing needs more real information, real reality, and real memory to behave towards an event. They attach great importance to experience and history or things that are based on facts that have been encountered, while the intuitive type only looks at facts as data to later develop itself into information. The intuitive type is more concerned with thinking about what happens behind a factual or what will happen later than what happened today. Someone who is more observant will be more grounded and more concrete in looking at the world. He pays more attention to practical events and immediate relationships. An observant will assume that everything important is born from what has been experienced, whether the experience is then ascertained as something that is true (judging) or the experience is allowed to remain open as it is (perceiving) [11].

Keirsey named people who were sensing and perceiving as artisan, and people who were sensing and judging as guardian. A person who is more introspective will put ratios or thoughts above everything and more abstract in looking at the world and focusing on global events. The Artisan type has natural intelligence and tactics (intelligence in tactics), which means the ability to see the situation quickly, evaluate many choices, and take action to get the desired results [12].

We know that each student has a different and unique personality. This is supported by Zhang (2015) that each is unique. It means that a human being is different from other humans, and there is no same real human in any side of the earth even though they are a twin [13]. Because of all reasons, the researcher is interested in researching learning mathematics difficulty on a student with artisan
character type in trigonometry HOTS problem-solving. Many mathematics skills are involved in solving a problem. However, most students have mastered the necessary skills needed to solve a mathematics problem [14]. This study is referred on the previous study conducted by Tambychik, which discuss the students’ learning difficulties, especially on number fact, arithmetic, information, language, and visual-spatial skill [15]. This research was conducted to reveal all of the difficulties experienced by artisan character students who have been taught by using SNH in solving HOTS trigonometry.

This research, hopefully, will help the teacher to understand the characteristic types of his students, which could help him to arrange an appropriate learning strategy. By using the SNH, it is expected that students will be more active and finally experienced meaningful learning.

2. Methods
This research used the descriptive-qualitative method. This research described artisan character students' mathematics learning difficulties in solving HOTS trigonometry problem. Character type questionnaire was done to 31 students to classify their characteristic. The characteristics questionnaire instrument validity was verified by an expert lecturer in psychology and an internal consistency test. Then, trigonometry HOTS test and interview were done and analyzed to know their problem-solving ability. The trigonometry HOTS test instrument validity was verified by mathematics lecturer, and the reliability test was done by using Cronbach alpha. All of the instruments are developed by the researcher. Subjects in this study were artisan character students taught by using SNH in SMAN I Kalidawir Tulungagung. Purposive sampling technique was used to choose the subject based on previous semester achievement and consultations with mathematics teachers at SMAN 1 Kalidawir. The subjects are B1 with low ability, B2 with moderate ability, and B3 with high ability. HOTS trigonometry answer and interviews data were processed to catch the conclusion of their learning difficulties. This study use stages of research carried out by Ary (2000) include: (1) Selecting problems (2) Analysis (3) Selecting strategies and developing instruments (4) Collecting and interpreting data (5) Reporting research results. The data credibility was verified by triangulation of methods [16].

3. Result and Discussion
From the characteristic type questionnaire done to 31 students of SMAN 1 Kalidawir, the researcher found 13 students with artisan type. The complete result is shown in Table 1.

| Character | Frequency | Percentage |
|-----------|-----------|------------|
| Guardian  | 9         | 29.03%     |
| Artisan   | 13        | 41.94%     |
| Rasional  | 5         | 16.13%     |
| Idealis   | 4         | 12.90%     |
| Total     | 31        | 100%       |

Table 2. Total Number of difficulties in mathematics skill

| Skill       | Hot Question 1 | Hot Question 2 | Hot Question 3 | Total |
|-------------|----------------|----------------|----------------|-------|
| Number fact | 0              | 2 (2.02%)      | 0              | 2 (2.02%) |
| Arithmetics| 2 (2.02%)      | 6 (6.06%)      | 5 (5.05%)      | 13 (13.1%) |
| Information| 11 (11.11%)    | 11 (11.11%)    | 12 (12.12%)    | 34 (34.34%) |
| Language    | 9 (9.09%)      | 8 (8.08%)      | 10 (10.10%)    | 27 (27.27%) |
| Visual spatial | 7 (7.07%)   | 7 (7.07%)      | 9 (9.09%)      | 23 (23.23%) |
| Total       | 29 (29.29%)    | 34 (34.34%)    | 36 (36.36%)    | 99 (100%)  |
Then, from the HOTS test, the researcher found that the highest number of difficulties founded was in question number 3 with 36.36%. The complete result is served in Table 2.

3.1 Analysis of problem-solving HOTS Question 1

Analysis and Evaluation of Cognitive Levels

In the picture beside there is an ABC triangle, how do you solve the problem? Explain your reason!

![Figure 1. Triangle figure illustration](image)

On HOTS 1 at the evaluation and analysis of cognitive levels, subject B1 found some difficulties. He solves the problem using the Pythagoras formula, and the reason is that it is a triangle figure. Subject B2 confused whether to use sine or cosine rules. Subject B3 responds firmly that it can be solved using the sine rule because the two sides, and one angle in front that side have been known. Based on the HOTS test and interview analysis, subject B1 started to analyze the questions appropriately, but at the evaluation stage, he could not complete the answer correctly. Subject B1 has difficulties in mathematics skills. In information skill, there are some difficulties in problem-solving planning, students could not see what was known and what was being asked on the question, but at the time of the interview, the student also feels awkward with his answer because this is a triangle, but it does not look like a right triangle. However, he can not give another alternative solution, remember the formula or understand the concept of trigonometry at all. This student's answer is in line with the character of artisan person who tends to be fast in making decisions. In language skill, there are difficulties in understanding the question. In visual-spatial skill, he was not able to understand trigonometry problem served in the form of an image. According to Polya, the first stage of the problem-solving process is understanding the process [17]. During the understanding problem stage, first, the student has to know the story and the objective of the problem from the information given.

3.2 Analysis of problem-solving HOTS Question 2

Evaluation of Cognitive Level

![Figure 2. Illustration](image)

A tree grows vertically in a mountainous area. The surface of the soil from the mountainous area has a slope of 16° to the horizontal line. If the length of the shadow of the tree is 18 meters when the elevation angle produced by sunlight is 68°, determine the height of the tree!. On HOTS 2 at the evaluation of the cognitive level, subject B2 found some difficulties. He has difficulty in planning to solve the problems. He does not write anything about what is known in the problem, which makes it difficult to solve it. From the interview and analysis of HOTS answer, B2, with moderate ability, started to answer by analyzing the questions appropriately, but at the evaluation
stage, he could not complete the answer correctly. He understands the problem, but he is too lazy to write and solve it even though he has an idea of how to solve it. In the end, he experienced many errors. It is concluded that he has trouble with information skill. He also has difficulties in arithmetics skill. It is known when he adds up the acute angle formed by the tree and the surface of the soil $\alpha + 90^\circ + 16^\circ = 180 \Leftrightarrow \alpha + 96 = 360 \Leftrightarrow \alpha = 74^\circ$. According to Narayanan, a lack of conceptual understanding will lead to weak arithmetical and procedural knowledge [18].

From the answers on subject B1, it is known that the answer is wrong and not finished yet. It seems that there is no problem in the accuracy of calculations, computational, and mathematical working procedures. He does not write information shown from the question, and he also has difficulties in determining the total measurement of the angle. From the answer, it is known that he answered it carelessly. It means that he has difficulties in arithmetic, information, and language and visual-spatial skills. It makes him failed to solve the problem correctly. Tambychik stated that students have problem-solving difficulties due to their lack of ability in visualizing mathematics problems and concepts [15]. Then, the effect of difficulties in mathematics concept is cumulative because further mathematics skill is developed based on previous knowledge [19]. For subject B3, he answered correctly, but his answer is different from his calculation.

### 3.3 Analysis of problem-solving HOTS Question 3

#### Analysis of Cognitive Level

Haris tried to determine the height of the flame at the top of the monument by measuring the angle of view as $\alpha$ from the foot of the monument. If the viewing angle is $\alpha$ and $\beta$ as shown. If $x$ is the height of the flame then $x = \ldots$

![Figure 3. Tower figure](image)

From figure 3, it was known that the answer given by B3 on HOTS question 3 is based on the cognitive level analysis.

From the very beginning, B3 has analyzed the question incorrectly. He has difficulties in visual-spatial skill which. He failed to understand the problem and being tricked by the picture in the question. Andersson stated that a child with a visual abnormality is often unable to differentiate pictures form [20]. Moreover, he also has difficulties in language skill. He concluded that the problem could not be solved because the measurement of the angle is not known.

Remembering to work on this problem, of course, the subject must pay attention to the questions that exist in it so that he can understand what the researcher means to say. If we read the question more, we will be able to determine the angle by reducing $\alpha - \beta$, then we substitute the height of the tower along with the tobyt. It will be obtained $\tan \alpha = \frac{t}{a} \rightarrow t = a \tan \alpha$. Likewise, looking for $\tan \beta = \frac{t-x}{a} \rightarrow t-x = a \tan \beta$. Then, $x = t - a \tan \beta$ so that the final result is the high flame is ($\tan \alpha - \tan \beta$). But then he doesn't pay much attention to what is known about the problem. Factors causing students experienced it is because of reading and understanding the difficulties he has.

Meanwhile, the B1 final result is right, but the reason is incorrect. Thus, the answer is still wrong because between the answer and question are inconsistent. This means that B1 has information and language skill difficulties. In visual-spatial skills, he has a problem in manipulating the image. Garderen stated that low visual-spatial skill might cause some problem in differentiating and relating information meaningfully [21]. Besides, the answer to subject B2 was wrong. It seems that
e has difficulties in understanding the problem. It is founded that he has difficulties in visual-spatial skills when translating the image of the monument into the mathematical sentence.

From the results of this analysis, this research found some difficulties of the artisan students. This research was proofing earlier research about students' difficulties in understanding trigonometry, especially on the problem formed in pictures. This is because students find it difficult to translate the information in the picture into mathematical sentences [22]. This result is also strengthened by previous research conducted by Istadi (2017) that difficulties are faced by students in Kalimantan to represent trigonometry questions from mathematical sentences verbal, visual, and symbolical form. The most difficulties founded are language, information, and visual-spatial skills with some various causes. Lack of question understanding caused the students to answer it incorrectly. These findings are also strengthened by Tambychik and Meerah's research, which found that the weaknesses of most students are at number fact, visual-spatial, and information skills [15].

4. Conclusion
From the three cognitive level, analysis, evaluation, analysis, and evaluation, it is founded that many students with artisan type who have been taught by using SNH have difficulties in HOTS trigonometry. The difficulties are 2.02% in number fact skill, 13.1% in arithmetics skill, 34.34% in information skill, 27.27% in language skill, 23.23% in visual-spatial skill.

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