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Computational Thinking: Vocational Students Abstraction in Solve the Geometric Pattern Problem

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ABSTRACT

The aim of this research is to explore the students' abstraction in solving geometric pattern problems based on gender. The subjects are 31 students in Grade X Multimedia, consisting of 12 male students and 19 female students. This research is qualitative descriptive research. Geometric pattern problems and interview guides are the instruments in this research. The results show that female students can master the concept of geometric patterns to solve the problem easily. Beside, they use the knowledge to represent the object and write the general term well. For male students are still not able to master the concept. In the several stages, they still using the manual way to solve the problem and still not able to represent the object well. In the problem-solving stage, they still do mistakes. A recommendation for future study is to explore further about students' abstraction in other mathematics problems.

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1. INTRODUCTION

Lately there has been a lot of discussion about computational thinking, including computational thinking in mathematics learning. One of the stages of computational thinking is abstraction. Abstraction is a vital essence and basic component in computational thinking (Maharani, Nusantara, As'ari, & Qohar, 2019; Masfingatin & Maharani, 2019; Mgova, 2018; Rambally, 2017; Wing, 2008). In mathematics learning, abstraction is equally important because mathematics is a science with an abstract structure.

Abstract basic object in mathematics defined as mental object or the object of thinking (Khine, 2018). That is consist of: (1) fact, (2) concept, (3) operation or relation and (4) truth (Soedjadi, 2000). Concept is abstract idea who applied to grouping several object. In mathematics, students should be held the concept by self. A series of abstract concept formation activities is an abstraction process, while the main feature of abstraction is the search for the same or general properties from a set of real examples. (Liu & Wang, 2010; Swasti Maharani, Kholid, Pradana, & Nusantara, 2019a).

Abstract thinking can be defined as a mental process that aims to infer results and extract abstract meanings from things and relationships by means of hypothetical thinking through symbols, generalizations, and the ability to make assumptions and validate them (Aseeri, 2020). The word abstract is closely related to abstraction. Abstraction is a fundamental process in mathematics because

abstraction skills allow students to construct mathematical concepts in their minds using prior knowledge (Adelia, Susanti, Sari, & Simarmata, 2020).

In learning mathematics, abstraction is an important construction that is often associated with empirical philosophy so that it can be considered as high-level knowledge which includes classification and generalization (Nurrahmah, Rochmad, & Isnarto, 2021). Abstraction in mathematics is an important process in mathematical thinking, in addition to powerful visualization to look for mathematical problems and giveeaning to mathematical concepts and the relationships between them (Yilmaz & Argun, 2018). This is in line with the opinion expressed (Nihayah, 2021) that abstraction (abstract thinking) in mathematics is very important because abstraction ability is an ability that can describe situations or problems in mathematics, therefore, one must have the ability to think abstractly.

One of the presentations of abstraction is for example fields, patterns, measurements, and mapping. One of the materials that discuss patterns, fields, measurements and mapping is patterned geometry because it not only develops students' cognitive abilities but also helps in the formation of memory, namely concrete objects become abstract (Khotimah, 2013). Geometry patterns train students to have high self-confidence, solve problems well, reason, and communicate mathematics well (Maharani, Agustina, & Kholid, 2021). Besides that, learning about patterns can help students develop their reasoning power, especially inductive reasoning. It can also help students take generalizations because it is very important in solving mathematical problems (Fauzan & Diana, 2020). Looking for patterns in sequences (concrete, numerical, figurative) to achieve generalization through rules that students formulate using symbols allows gradual learning of mathematics and achieves abstraction.

However, students' abstraction abilities in solving pattern geometry problems are still not as expected (Fuady, Purwanto, Bambang, & Rahardjo, 2019; Gadanidis, 2017; Mitchelmore & White, 2007). Based on the experience of researchers when teaching mathematics at SMK, there are still many students who are still unable to solve patterned geometry problems and have not been able to abstract mathematical concepts correctly. Students are only able to read formulas and examples of questions without understanding the concept. Students need to analyze and look for similarities in characteristics to form patterns in solving pattern geometry problems. Analysis is carried out to solve complex problems more easily. Abstractions, generalizations, andhe algorithms used must also be precise (Maharani, Agustina, & Kholid, 2021).

Meanwhile, in terms of Piaget's theory, someone aged more than 11 years should be able to think abstractly, namely at the formal operational stage (Umbara, 2017). Several previous studies, such as those conducted by As Elly and Novianti Mandasari in 2018 with high school students as subjects, showed that the level of abstract thinking of high school students in understanding geometric concepts and principles is still low. The results of research conducted by Anis Dwi Nihayah on high school students in 2021 also show that there are still many students who are unable to manipulate mathematics. The results of this study are also in line with the results of research conducted by Iik Nurhikmayati in 2017, namely that there are still many students who have difficulty thinking abstract mathematics.

Based on the results of several previous studies, the difficulties experienced by students in abstract thinking can be influenced by several factors. Among them: 1) Difficulty in solving questions with abstract concepts, this is thought to be related to how to form abstract mathematical objects (Nurrahmah, Rochmad, & Isnarto, 2021), 2) lack of ability to apply concepts in appropriate contexts and manipulate abstract mathematical objects and minimal use of visual aids in learning (Nurhikmayati, 2017), 3) Lack of giving questions or problems that require students to think abstractly (Nihayah, 2021), 4) Level of students' abstract thinking ability, 5) Gender, as stated by (Santrock, 2007) male students do slightly better than female students in math and science. In general, male students are the same as female students, but the abstraction power of male students is better than female students so that male students are better than female students in the field of mathematics, because in general mathematics deals with abstract understanding, 6) Aspects cognitive students, and 7) learning styles.

Based on the explanation above, it can be concluded that abstract thinking is very important in learning mathematics. The low ability of students to think abstractly is one of the problems in the world of mathematics education. The application of abstract thinking is needed by students in solving problems both in the learning process and in everyday life problems. Therefore the researcher wants to focus more on knowing the abstract thinking processes of students at the SMK level in mathematics with the aim that this research can be used as a reference for teachers to find out students' abstraction processes so that teachers are able to choose appropriate learning methods in improving students' abstract thinking processes. There have been many studies that examine abstract thinking, but each study has its own characteristics related to this theme. In this study, researchers focused more on how the process of abstract thinking is seen from a gender perspective. So that the results obtained are how the thinking processes differ between male and female students.

2. METHODS

This research is a qualitative descriptive research that aims to analyze how the abstract thinking processes of vocational students in solving patterned geometry problems. The subjects in this study were SMK students from one of the private schools in Madiun. The subjects used were all students of class X Multimedia, totaling 31 students. Of the 31 research students, 4 people were taken as subjects, consisting of 2 boys and 2 girls, each of whom had different abstract thinking skills. The subject selection procedure was by giving patterned geometry problem instruments to 31 students. Subject criteria are based on abstract thinking indicators. In this study, 4 students were taken who met the criteria as subjects. The answers of the 4 subjects were analyzed further, and then interviews were conducted regarding the answers to find out deeper abstract thinking processes.

The main instrument used in this study was a patterned geometry test. In addition, there is a supporting instrument, namely an interview guide. Patterned geometry question sheets contain one question that is used to obtain data in the form of subject answers to be analyzed to find out what indicators of abstract thinking are met. This patterned geometry problem test was carried out at the beginning of the study, where the questions had previously been validated by two mathematics teachers. Here are the pattern geometry test questions.

In a garden, a toy ladder of bricks will be built, as shown in the picture. The number of bricks used from layer to layer always increases by the same amount. The topmost layer is called the 1st layer, the layer below it is called the 2nd layer, and the bottom layer is the last layer. If the 3rd layer consists of 22 bricks and the 7th layer consists of 46 bricks, then determine the number of bricks in the top and bottom layers.

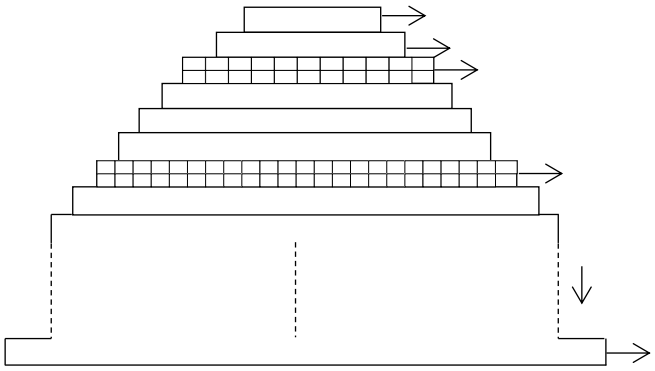

Figure 1. Geometric Pattern Problem

The second research instrument is an interview guide. The interview used in this research is a semi-structured interview. Interviews were conducted to obtain more valid data regarding the results of the subject's written answers. Interviews were conducted after the subject was selected.

This research begins with submitting a title and preparing a research proposal. Then proceed with the preparation of research instruments. The researcher compiled patterned geometry tests and interview guidelines which were then validated by two validators, namely mathematics teachers. The interview guide was prepared based on indicators of abstract thinking. After the instrument was valid, the researcher conducted research by giving geometric pattern questions to all 31 students, who then took 4 subjects. The topic of the interview is related to the answer he wrote. For clearer research procedures can be seen in diagram 1 below.

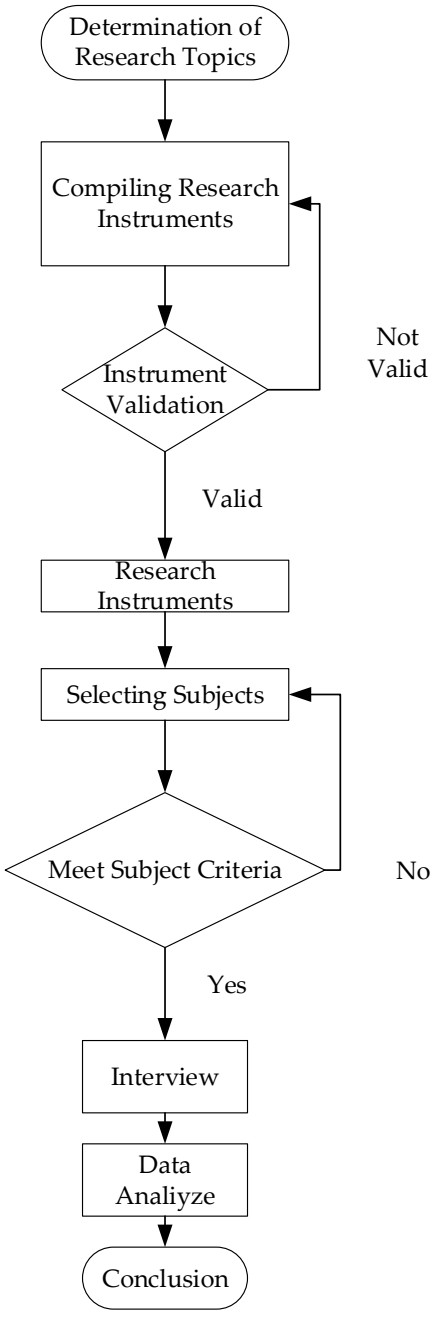

Diagram 1. Research Proccedure

Data analysis techniques in this study include:

1. Data Reduction
   Data reduction is the process of selecting, focusing, focusing on simplifying, abstracting, and transforming data that emerges from field notes.
2. Data Presentation
   Data presentation is a representation of the data generated to facilitate the process of data analysis.
3. Conclusion
   The conclusion is the core of the research results which explain opinions based on previous descriptions or decisions obtained based on inductive or deductive thinking methods.

3. FINDINGS AND DISCUSSION

The data in this study is the result of the subject's answers and interview results. The first category is that female students are able to fulfill all indicators of abstract thinking, work on and answer questions given systematically and use mathematical concepts properly and correctly, and say that the questions given are questions of arithmetic sequences. In addition, female students can determine that the problem is an arithmetic sequence because they are able to understand the concept and properties of an arithmetic sequence. This can be seen in Figure 2.

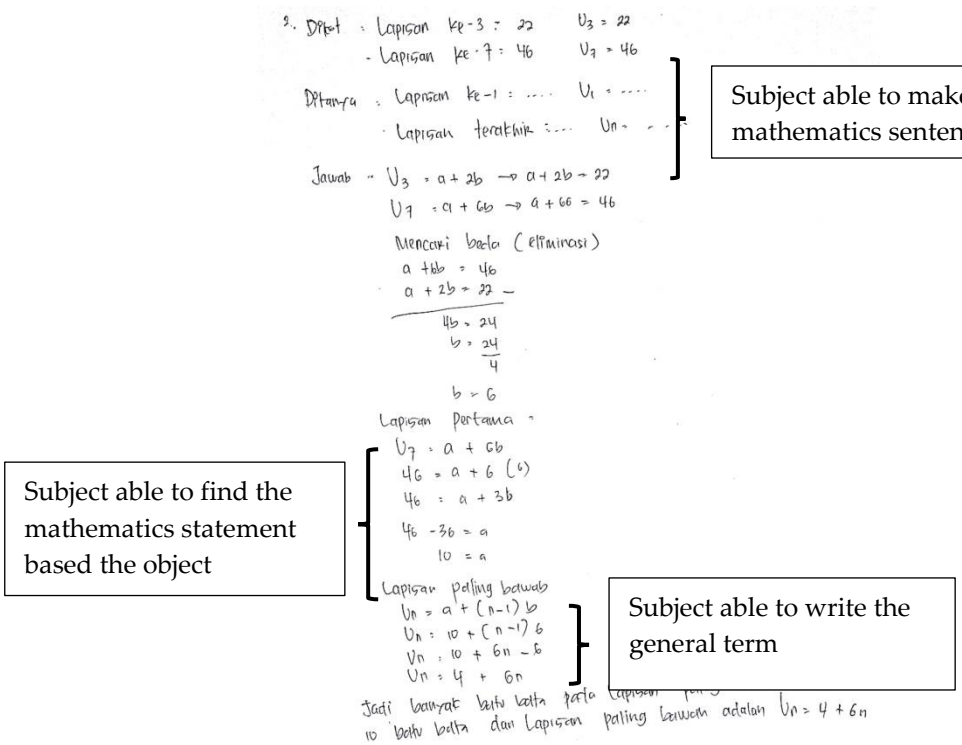

Figure 2. Female students answer

Figure 2 is the answer from female students. It can be seen that in solving the problems given, female students can analyze and understand the questions well so that they are able to solve the problems correctly and precisely. Female students are also able to understand the pictures in the questions well. The information on the questions received by female students was that there were 22 bricks in the 3rd layer and 46 in the 7th layer. Then, the question is included in an arithmetic sequence because it states that the difference in each layer is also the same. Female students are able to make a mathematical model from the information mentioned in the problem. He exemplifies the 3rd and 7th

layers, which are then used to find different values. After finding the difference, he calculated the values of a and b to find the general form of the n-th term.

On the other hand, male students are able to fulfill two indicators of abstract thinking. Even though this male subject was able to determine that the question was an arithmetic sequence and could write down the general form, the male subject could not fulfill the other 3 indicators. Completion carried out by male subjects is different from female students. Male subjects are still not able to write mathematical symbols from known information. In addition, the subject is not used to using pictures when solving a math problem. Several steps are lacking in solving the problem, as shown in Figure 3.

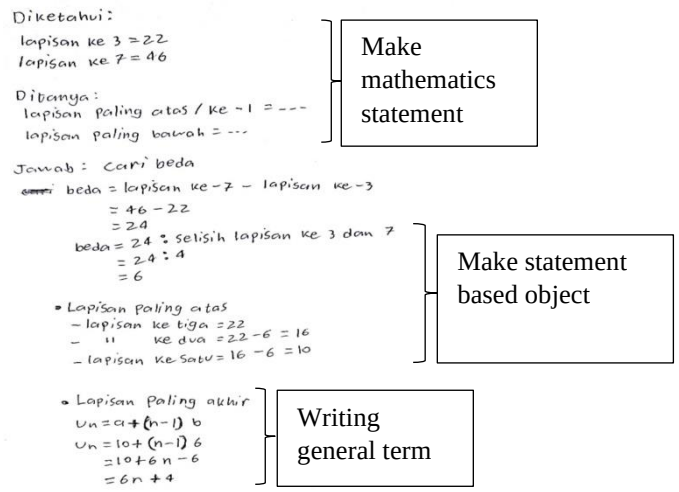

Figure 3. Male Students Answer

It can be seen in determining the difference between the two subjects not using the sequence formula and then being eliminated as was done by female students. Even though the answers that the male students got were correct, in that way the chances of making mistakes were greater, so it was not recommended to use the method that male students used. In addition, male students do not use formulas in determining the top layer or layer 1 due to a lack of understanding of the concept in male students. This is supported by the statement of the male subject in the interview as follows:

R : *"What do you understand from question number 2?"*
S2 : *"In the garden a ladder will be built, in the 22nd layer there are 46 bricks in the 7th layer. Lha is asked to find the top layer and the bottom layer."*
R : *"Apa yang kamu pahami dari gambar pada soal?"*
S2 : *"yes, that's a picture of the stairs like that."*
R : *"How do you model the problems presented in mathematical form?"*
S2 : *"I am sorry, I forgot it.*
R : *"What are the steps you did? Explain!"*
S2 : *"There's no difference with the first layer or U_1. Yes, so look for a difference first. The way I used to reduce the value of the 7th layer is the same as the 3rd, and then I divided it by 4. After that, look for the topmost layer. I reduced the method madam, so look for the 2nd layer first and then the top layer like this ma'am (Points at the answer sheet)."*
R : *"Why don't you work using the formula?"*
S2 : *"I forgot the formula ma'am."*
P : *"How do you get the general form of the questions given?"*
S2 : *"Immediately, ma'am, I enter the difference from a into the formula, the answer is found $U_n = 6n + 4$."*

Based on the data presented above, female students solve problems coherently and systematically. Female students are able to fulfill all indicators of abstract thinking, namely: 1) Able to manipulate and determine the nature of objects, 2) Able to represent physical objects based on their nature, 3) Able to make mathematical sentences, 4) Able to find statements based on objects, 5) Able to write shapes generally.

Female students are able to manipulate and determine the nature of objects. They are able to relate material to the properties of the questions given and are able to analyze and classify based on level. After analyzing the questions, female students observed the pictures in the questions, they understood that the pictures contained a pattern that could later be used to solve existing problems. With the visualization of images, it will make it easier to solve complex problems in mathematics (Maharani et al., 2019; Maharani, Kholid, Pradana, & Nusantara, 2019b; Masfingatin & Maharani, 2019) (Hamidreza, Alias, Kahar, Buhari, & Zakaria, 2015). Image visualization is included in the second indicator of abstract thinking, namely representing the shape of an object. Even though the female students did not re-draw the picture, they were able to explain what information was contained in the picture. Image representation is able to increase understanding and has a major influence on students in learning solutions to a problem (Maharani, Agustina, & Kholid, 2021).

Besides that, female students are able to use mathematical symbols to change questions into mathematical models. On the other hand, the subject is also able to determine whatever U value is requested and write down the general form fluently, precisely and correctly. The subject correctly and consistently answered the researcher's questions based on the results of the tests carried out. Based on the results of the analysis, the abstract thinking process of female students is very good. As stated by Wahyuni, Sudarisman, & and Karyanto (2013), students can be said to be able to think abstractly if they are able to predict, make the right conclusions and solve problems correctly without real objects.

In the case of male students, those who solve problems tend to write numbers or letters rather than in the form of mathematical symbols. They are also not used to representing problems and only focus on the end result. It can be seen in Figure 3 that in determining the difference, you should be able to use the sequence formula and then do the elimination to get the value b. However, male students use their own way which can lead to mistakes. Besides that, in determining the first layer, the subject calculates manually by reducing each layer with the value that has been obtained. The method used by the subject is less effective due to a lack of understanding of the line material. Even though to find the first layer, you can use a formula by substituting the b value into one of the formulas, as was done by type 1 subjects. Even so, type 2 subjects can still write down the general form after knowing the a and b values. From the results of the researcher's analysis, it can be said that type 2 subjects have not been able to think abstractly because they have not been able to represent the subject, write general forms into mathematical symbols and solve problems correctly.

4. CONCLUSION

Based on the results of the research and supporting theory, it can be concluded that female students have good abstract thinking processes because they have been able to fulfill all indicators of abstract thinking, namely manipulating and determining the nature of objects, representing objects in the form of images well, being able to write general forms correctly, being able to solve problems. given in a coherent, clear, and precise manner, and able to write down the general form. Meanwhile, male students do not yet have a good abstract thinking process because they can only fulfill 2 indicators of abstract thinking, namely being able to manipulate and determine the nature of objects and writing general forms. At the same time, other indicators cannot be fulfilled due to the lack of understanding of the subject concept in abstracting a problem.

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