Guardian high school student’s conception about mathematics as sensible

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Abstract. One of the characters that students should hold as the effect of learning mathematics is positive character about mathematics. It means students believe that mathematics is sensible. Students who view mathematics as sensible think that mathematics is interrelated concepts and mathematics is related to other concepts. Students’ conception may be different because basically human have different personalities. There is a relation between student conception about mathematics and their personality type. One of the personality type based on Keirsey Temperament Sorter is guardian. This study describes guardian high school student conceptions about mathematics as sensible. One female student whose personality type is Guardians is purposively selected as a research subject. The subject is assigned a mathematics real world problem and interviewed based on the problem solving task to measure her conception about mathematics as sensible. The interview guideline is developed based on SCOMAS framework. The result indicates that guardian subject shows the conception that mathematics is sensible. However, not all of the indicators can be verified. The subject plans a strategy and alternative strategy to solve the problem, explains the way to solve the problem and the reason of applying some concepts, and connects the solution to the real situation. The subject doesn’t show the activity of seeking connection among mathematics concepts.

Key words: conception, personality, guardian

1. Introduction
Mathematics is one of subjects which must be studied in elementary and high schools. The aims of studying mathematics are to solve complex mathematics problem, learning various mathematics topics, and awarding and showing a good will in learning mathematics [7]. One of interesting aims in learning mathematics is to give positive value on mathematics, that mathematics is systematic and related system. Mathematics is related means that the concepts among mathematics are connected and also mathematics is connected with other subjects and the real world. This view is square with what Grady says as the conception of mathematics as sensible [5]. In other terms, Schoenfeld call this view as mathematical belief [3]. The conception of mathematics as sensible doesn’t need someone to show logical argument of a mathematics concept, it only needs someone to believe and to realize that mathematics is connected.

There are three types of people view on mathematics. The first is problem solving view which is defined as the ways of viewing mathematics as dynamic knowledge, and develops based on the existing problems so that mathematics cannot be separated from the real world problems. The second is Platonist view which is a way of viewing mathematics as system of static knowledge but interconnected. And the third is instrumentalist view, which is a way of viewing mathematics as
separated concepts [4]. Hence, problem solving view is similar to what Grady says as the conception of mathematics as sensible.

Each expert who talk about the conception about mathematics always talk about a way of viewing mathematics that mathematics is interrelated concepts and connected to the real life. Students’ conception about mathematics as sensible also can be stated as mathematics related belief [3]. In this study the term that will be used is as stated by Grady, the conception of mathematics as sensible.

Students’ conception about mathematics strongly affects their mathematics achievement [3]. A research about a non-cognitive predictor to the mathematics achievement shows that mathematical belief becomes the best predictor [9]. Students’ mathematical behaviour is not only influenced by students' mathematical experiences, but also by a set of conceptions.

Students' conception of mathematics has a positive effect on their mathematics achievements. There are differences about the relationships between students’ conception of mathematical achievement in male student and the relationships between students’ conception of mathematical achievement in female student [8]. The relationships between students’ conception of mathematical achievement in male student is stronger than the relationships between students’ conception of mathematical achievement in female student.

The conception of mathematics as sensible does not require someone to understand the interrelationship between mathematical concepts, but is limited to belief or awareness that mathematics is a mutually related concepts and connected to the real world [5].

Some researches on students' conceptions of mathematics have been carried out, and analysed in quantitative approach [1], [2]. In these studies, students' conception about mathematics was approached quantitatively and generally classified conceptions students into categories that have been predetermined. In this study, students' conceptions of mathematics were approached qualitatively.

A framework for evaluating students' conceptions of mathematics called the SCOMAS framework consists of four aspects that has been developed [5]. Each aspect consists of several indicators. The SCOMAS framework contains indicators that students’ conception of mathematics is meaningful. The SCOMAS framework is presented in Table 1:

| No. | Aspect                  | Indicator                                                      |
|-----|-------------------------|----------------------------------------------------------------|
| 1.  | Strategizing            | 1.1 Developing a problem solving strategy                      |
|     |                         | 1.2 Developing alternative strategies                          |
| 2.  | Asking explanation      | 2.1 Explaining why                                             |
|     |                         | 2.2 Explaining how                                             |
|     |                         | 2.3 Explaining the reasons for using a concept / strategy      |
| 3.  | Seeking for connection  | 3.1 Investigating the relationship between mathematical concepts|
|     |                         | 3.2 Investigating the relationship between mathematics and other concepts|
| 4.  | Assuming authority      | 4.1 Believing in the truth of the solution obtained             |
|     |                         | 4.2 Believing in mathematical truths                           |

Conception is developed by someone experience in school or outside a school [1]. Every person has their own way of thinking, recognizing something, and developing concept. The way of doing those activities is called personality [6]. Personality can be classified into four types, i.e., Guardian, Artisan, Rational, and Idealist [6]. Guardian student tends to feel comfort in traditional learning. Guardian student places the teacher as the centre of learning, accepts what are delivered by the teacher.
as a good thing. Guardian student tends to study in a rut and complete the task on time. Guardian student will easily study if the materials are served in order and sensible. Guardian student doesn’t like discussion [6].

Based on these opinions, it can be concluded that there is a relationship between students’ conception of mathematics and their mathematical abilities, and can be estimated that there is a relationship between students’ conception of mathematics and their personality type. As far as the researchers know, there is no research about students’ conception about mathematics and their personality type. This research tries to analyze student conception about mathematics based on a type of personality, which is guardian. Therefore, in this study we will try to explore guardian student conception about mathematics as sensible.

2. Methods
This study belongs to descriptive research with qualitative approach which is aimed to describe a vocational high school student with guardian type of personality about mathematics as sensible. This study analyses qualitative data which are obtained by giving written tests and interviewing the subjects.

Participant in this study is one grade 12 student of vocational high school. One group of students is chosen randomly to be given mathematics test and personality test. Based on the result of the mathematics test, students are classified based on their mathematics test score as shown below:

| Score       | Class   |
|-------------|---------|
| 87 ≤ score ≤ 100 | High    |
| 75 ≤ score < 87  | Midle   |
| 0 ≤ score < 75   | Low     |

One female guardian student with high mathematics ability is chosen as research subject. The research subject is then assigned problem solving task and interviewed to elicit her conception about mathematics as sensible.

The data in this study are collected by using two methods, paper and pencil tests and interview. Paper and pencil tests are held to get the data about students’ mathematics ability, students’ personality, and students problem solving skill. Interview is held to clarify students’ problem solving process and to get more information which are not gotten from the paper and pencil tests.

3. Result and discussion

![Figure 1. The answer of Guardians student in Problem Solving Tasks](image-url)
From the results of the work it appears that the subject uses a strategy of making equations to help solve the problem. The mathematical concept used is linear equation with two variables and the methods she uses are elimination and substitution method. The subject used $y$ to express the maximum of heartbeat frequency and $x$ to express the age. After making two equations, the subject applied elimination method to solve for $x$. After the subject gets $x = 40$, she substitutes $x = 40$ to the equations such that she gets $y = 180$. Substituting $x = 40$ to the equation indicates that the subject tries to make sure the solution is right.

To get more information, then the subject is interviewed.

Q: What does the problem means?
S: an old formula of the maximum heartbeat is \textit{the maximum heartbeat} = 220 – age, and the new one is \textit{the maximum heartbeat} = 208 – 0.7 \times \text{age}. Suppose $y$ is the maximum heartbeat and $x$ is the age.

Q: Why should you make supposition?
S: to find the result

Q: How could it be?
S: Here, the differences are 220 and 208, the maximum heartbeat and the age must be the same. If we make supposition will be easier.

Q: What is the goal of making supposition?
S: to make equations in $x$ and $y$, then subtract one from another.

Q: At first, do you directly think about that method?
S: No, at first I try to substitute $x$ by some number, but I stop it.

Q: Why
S: Because it will be difficult, since there are too many numbers to be tried.

From the interview we get the information that the subject plans a strategy to solve the problem that is trial and error. Then the subject realized the weakness of the method she uses. She must try too many numbers to find the correct solution. Then she tries another strategy, she made equations and applied elimination method. This indicates that the subject can explain why the strategy solves the problem or not. In solving the problem, the subject meets the indicators of SCOMAS framework that are strategizing and asking explanation.

Q: Have you found the solution?
S: yes, $x = 40$.

Q: have you checked it?
S: yes

Q: how do you check your answer?
S: by substituting $x = 40$ to the both equations?

Q: and what is the result?
S: from the both equations, I get the same result $y = 180$

Q: what does it mean?
S: It means the formula will get the same maximum heartbeat for someone who 40 years old.

Q: Is it possible?
S: No

Q: why?
S: because in the real life, there is no person whose frequency of the heartbeat is 180 per minute, it is normally 90-120 per minute.

From the interview, the subject tries to connect the problem with the real life. She says that the result she obtains doesn’t meet the real situation. She says that there is no person whose frequency of heartbeat is 180 per minute. The subject also tries to make sure that the solution solves the problem. This part indicates that the subject accept the mathematics result as the solution of the problem, even
she can’t accept it for the real situation. This meets the indicators of SCOMAS framework that are seeking connection and assume authority.

4. Conclusion

One of characters which is needed to be grown from learning mathematics is having conception about mathematics as sensible because it has strong relation whit students mathematics achievement. Students who have conception about mathematics as sensible tend to view mathematics as a related concepts rather than mathematics as a separated concepts. Students’ conception is affected by students experience in learning, and also affected by the way of getting the experience. The way of getting the experience is unique based on the personality. In solving mathematics problem, guardian student planning a strategy and alternative strategy, asking explanation, seeking connection, and assuming authority. It means that guardian student meets the indicators of SCOMAS framework. It can be concluded that guardian student have a conception about mathematics as sensible. For the future research, to get more accurate data about guardian students’ mathematics conception about mathematics, it probably needs to get the information about the way mathematics teachers teach the guardian students, because guardian students tend to accept what are delivered by the teacher. As explained before, students’ conception is developed by their experiences in school or outside a school.

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