Mathematical communication skill of senior high school students based on their personality types

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Abstract. Every student with different type of personality, extrovert or introvert, has his or her own characteristic. The difference of the personality type can influence their way of having confident attitude, communication, and other activities including learning. This research aims at analysing student’s ability of mathematical communication with extrovert and introvert personality type. This research is descriptive qualitative research. The data of this research was obtained from 34 students of senior high school in Sukoharjo region with heterogeneous abilities, collected using written test and interview. The result of the research gave an overview that mathematical communication skill of students having introvert personality can arrange conjecture, make an argument, and formulate generalization definition. However, they had difficulty in understanding a mathematical presentation. Meanwhile, the students having extrovert personality can explore their ideas, but they have difficulty in revealing the idea or mathematical paragraph in their language. In order to improve mathematical communication, students should be given mathematical problem related to mathematical communication and the teacher is expected to know the characteristics of the students so that the teacher can provide appropriate actions.

1. Introduction

Good education quality will result good academic achievement as well. Intelligence and personality are important factors to study in relation to academic achievement [1]. People have different characteristics that influence their life, these personal characteristics influence even their way of learning. These different characteristics are called person’s personality type [2]. Jung (in [3]) distinguished personality types into two kinds namely extroversion and introversion, the two of which refer to how far someone’s basic orientation directed outside (outside world) or inside himself.

According to Tiegier & Barron-Tieger, introvert personality is a nature of imaginative people which is self and idealism-centered, often or characterized as thinking hard before taking action or doing talk, more easily stimulated by new ideas and unusual situation, thorough, honest, and consistent. Meanwhile, extrovert personality is a nature of imaginative people which is outside world and idealism-centered, often or characterized as an act without thinking too hard. It tends to show more the person’s openly emotional situation, tends to be like acting directly which is better than fantasizing, and tend not to be consistent [4].

There is a meaningful connection between personality type and learning motivation, as well as the ability of solving problem faced by student [5]. A person with extrovert personality type more often uses movement and writing for communication compared to the introvert one [6]. Communication skill is strongly needed to sort and describe solution construction of analysis result, or logical description of mathematical problem appeared [7]. Communication is a transmission process of information, idea, emotion, ability, and so on.
through symbols, words, pictures, numbers, and others. Meanwhile, mathematical communication skill is defined as a person’s ability to write a mathematical statement, write reason or provide explanation of each mathematical arguments he uses to solve the mathematical problem; use terms, tables, diagrams, notations, or mathematics formula properly; and check or evaluate another mathematical thought [8].

The aim of mathematics learning deals five main standards of mathematics learning covering problem-solving, reasoning and verification, communication, connection, and representation [9]. In curriculum process standards, it is stated that the aim of mathematics learning are followings: (1) to solve problems consisting of ability to understand the problems, design mathematical models, solve the models, and interpret solution; (2) to communicate ideas with symbols, tables, diagrams, and other media to clarify situation or specific problem; and (3) to have attitude in respecting mathematical practice in daily life, consisting of having curiosity, concerns and interest towards learning mathematics, along with the tenacity and confidence in solving mathematical problem [10]. However, the student’s mathematical communication skill today has not yet fulfilled the expectation.

Some researchers have found one same problem that is low mathematical communication skill, seen from Trends International Mathematics and Science Study (TIMSS) report. It mentions that Indonesian students’ ability in mathematical communication is still very far below the other countries [11]. Meanwhile, in TIMSS 2015 report, Indonesian students are in the 45th position from 50 countries. Indonesian score is 397. Related to the reasoning, the ability of Indonesian students is still very low. The ability to reason is closely related to communication skills. Another research states that 58.54% of Indonesian students still have difficulty in student’s worksheet which has relation to difficulty in stating mathematical sentence and lack of student’s bravery in asking questions and responding to problems [12]. Remembering the importance of communication in mathematics learning and low mathematical skill in Indonesia, the necessity of student’s mathematical communication skill is fundamental so that in the following days the educator can determine appropriate methods and models to overcome various problems. Then, at the end, it will have an impact to the improvement of learning results [13].

The results [19] show that junior high school students had weak difficulties in visualizing mathematical ideas visually, making mistakes in demonstrating mathematical ideas and having errors when using mathematical terms. They also had problems in expressing mathematical ideas and in using structures of mathematics to present mathematical ideas. Based on those studies, researchers are interested in doing research on the communication skills of high school students. Because of the importance of mathematical communication in learning, then researcher was interested in having research about the student’s mathematical communication skill from the point of view of introvert and extrovert personalities, as other researcher had studied about the influence of mathematical communication to mathematics learning achievement [14]. Besides, there is also another researcher who did research about the influence of prospective mathematics teacher’s mathematics communication when teaching geometry [15]. Meanwhile, in this research, the questions used deals with linear program. There is also a researcher who compares mathematical communication between teacher and student [16]. Different from it, this research focuses on student’s mathematical communication. Moreover, even though there is also another researcher who had researched about communication through social media by seeing from introvert and extrovert personalities point of view [17], this research focuses on mathematics communication.

In this research, the indicators of mathematics communication skill covers analysing and writing information obtained into mathematical symbols; reading with understanding a mathematical equation; expressing ideas, mathematical situation oral or with picture, graph and algebra form; arranging conjecture, argument or formulating generalization definition; and revealing a mathematical sentence into its own language.
2. Method
This research was done through descriptive qualitative method. The method in this research dealt with analyzing student’s mathematics communication skill based on the introvert-extrovert personality he or has. The subject consists of 34 students of senior high school in Sukoharjo region with heterogeneous abilities. The students were selected through purposive sampling. The data used was mathematical questions and interview. Mathematical communication data were submitted through essay test carried out in 45 minutes. The essay topic for the test was about linear program. Next, the data was descriptively analysed. The data analysis techniques in this study included: (1) reducing the data, (2) the presentation of the data, and (3) conclusion.

3. Result and Discussion
In this study, indicators of mathematical communication skills were synthesized by Hendriana and Soemarmo and Yang, Chang, Cheng and Chan. The indicators are analyzing and writing information obtained into mathematical symbols; reading by understanding mathematical equations; express ideas, oral mathematical situations or with pictures, graphics and algebraic forms; regulate allegations, arguments or formulating definitions of generalizations; and expressing mathematical sentences into the students’s own language.

The result of this research shows the score and percentage of students’ mathematical communication indicators as provided in Table 1.

| No | Mathematical Communication Skill Indicators                                                                 | Personality                                      |
|----|----------------------------------------------------------------------------------------------------------|-------------------------------------------------|
|    |                                                                                                        | Introvert  | Extrovert  |
| 1  | Analysing and writing information obtained into mathematical symbols.                                     | 42        | 30,88%    | 107        | 78,68%    |
| 2  | Reading with understanding a mathematical equation.                                                        | 24        | 17,65%    | 79         | 58,09%    |
| 3  | Expressing idea, mathematical situation oral or with picture, graph and algebra form.                      | 58        | 42,65%    | 110        | 80,88%    |
| 4  | Arranging conjecture, argument or formulating generalization definition.                                   | 108       | 79,41%    | 24         | 17,65%    |
| 5  | Revealing a mathematical sentence into its own language.                                                   | 10        | 7,36%     | 41         | 30,15%    |

Based on Table 1, the students having introvert-extrovert personality could be classified into high, medium and low categories based on the percentage obtained. It was included in high category if the percentage was between 67%-100%, while it was included in medium category if the percentage was between 34%-66% and low category if the percentage was between 0%-33%. The following description is the research result consisting of general description about students’ mathematical communication skill dealing with introvert and extrovert personality. Some of the students’ answers can be analyzed as follows:

Figure 1 shows that the student analysed and wrote the information obtained into mathematical symbols by the permissibility variable $x =$ clothes type A, and $y =$ clothes type B. That student could express his idea shown by solving the problem with elimination way, but the student was not able to express his idea into the graph. The student explained that he still got confused and didn’t understand yet when drawing graph to find the intersection of the line. They should express their ideas in the graph so that the truth of the answer they got was correct. The student was also able to arrange the steps of the execution or conjecture correctly and arrange the arguments and formulate the generalization definition shown by the finding of the maximum profit. Figure 1 also shows that the student was not able to reveal a mathematical sentence into
his language yet, shown by his work in which the student did not write the final result or the conclusion of his work to answer the problem. The aforementioned statement was strengthened by the result of the student interview in which he stated: “...because I was confused to make a conclusion sentence. I think the important thing is that I have my answer already if the requested question is the value of $x$ and $y$ along with the maximum profit.”

Figure 1. Student’s answer with introvert personality

Figure 2. Student’s answer with extrovert personality

Figure 2 shows that the student analysed and wrote the information obtained into mathematical symbols accurately. Although the student was not able to read the mathematical equation correctly yet, he could express the ideas, the mathematical situation with oral or graph and the algebra form. Figure 2 also shows that the student could solve the problem by expressing the ideas into the graph and elimination way. The student was also able to arrange the steps of the execution or conjecture correctly, even though he did not arrange the arguments and formulate the generalization definition shown by the absence of critical point. The result was according to the student’s statement saying: “I am still confused to determine which the critical point is and how to draw the line.” The student also did not write the final result or the conclusion of his work to answer the problem, which meant that he was not able to reveal a mathematical sentence in his language. It was based on the student’s statement during the interview in which he said: “I was confused what sentence I should write for the conclusion, well, finally I just wrote the maximum profit.”

Figure 3. Student’s answer with introvert personality

Figure 4. Student’s answer with extrovert personality

Figure 3 shows that the student analysed and write the information obtained into mathematical symbols by the permissibility variable $x = \text{bag model I}$ and $y = \text{bag model II}$. The student could express his idea, shown by his problem-solving of the elimination. However, the student was not able to express his idea yet into the graph. They should express their idea into the graph as well so that the truth of the answer they got was no doubt. Such result was based on the student’s statement in the interview: “I was confused which
points used in order to make the graph, hence I just did the elimination although I was, sometimes, not sure with my answer because it was not so clear whether it was correct or not if it was done only through elimination.” The student was also able to arrange the steps of the execution or conjecture correctly and arrange the arguments and formulate the generalization definition shown by the finding of the profit of bag model I and II, although he was less accurate in substituting the value of the capital. Such result was according to the student when he said: “I was confused how to multiply it to find the profit. Then, I had a thought to use the value of x and y I had found in the beginning.” Figure 3 also shows that the student was not able to reveal a mathematical sentence into his language yet, shown by his work where the student did not write the final result or the conclusion of his work, he wrote only the total profit. Such result was based on the student’s statement in which he stated: “I was confused about arranging the sentence and I thought if the maximum profit is equal to the total profit, so I just wrote like that to answer it.”

Figure 4 shows that the student was able to analyse and write the information obtained into mathematical symbols by the permissibility variable x = bag model I and y = bag model II. The student could express his idea shown with his problem-solving dealing with the elimination and graph as well as the ones in the form of algebra, which were shown by the graph and by the finding of the value of x and y done through the elimination. The student was also able to arrange the steps of the execution or conjecture correctly and arrange the arguments and formulate the generalization definition shown by the finding of the profit of bag model I and II, without writing the critical point obtained from the graph. Such finding was based on the student’s statement in which he said: “I did not understand which number it was supposed to be substituted and how to complete the critical point.” Figure 4 also shows that the student could reveal a mathematical sentence into his language, shown by his work where the student wrote the final result or the conclusion of his work. The total profit was 17.000 and it was the result when he was in a hurry to take the conclusion which made him solve the problem incorrectly. Such finding was based on the student’s statement in which he stated: “I am sure if the total profit is the sum of profit I and profit II, and since I wished to finish it soon, therefore I just answered in that way so that I was able to finish it soon.”

From some of the students’ answers analyses above, it can be concluded that students with extrovert personality had better mathematical communication than those who had introvert personality. This is in line with a research which states that “professional commitment between teacher and students having extrovert personality is significantly different from those who have introvert personality [4].” It also supports that different personality type influenced their attitude a lot toward language learning through internet usage, where the students having more extrovert personality experienced high integration in ITC compared to those who have introvert personality [18]. Moreover, there was a difference in communication intensity through social media in which extrovert personality type had higher communication intensity in comparison to the introvert personality type [17]. However, if we see in Table 1, every person had high and low presentation. The students who had introvert personality could arrange conjectures, arguments, to formulate generalization definition, but had difficulty in reading with understanding a mathematical presentation. Meanwhile, the students who had extrovert personality could explore ideas, but had difficulty in uncovering an idea or a mathematical paragraph in their language.

4. Conclusion
The analysis result above gives an overview that mathematical communication skill of the students who had extrovert personality was better than those who had introvert personality. However, every person had advantages and weakness, as well as the mathematical communication skill of the student who had introvert personality, and he could arrange conjectures, arguments, formulate a generalization definition, but had difficulty in reading by understanding a mathematical presentation. Meanwhile, the students who had extrovert personality could explore his ideas, but also had difficulty in revealing an idea or mathematical
paragraph in their language. Therefore, the students should be given mathematical problems exercises so that the mathematical communication for each student can be stimulated and be better.

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