The Mathematical Communication Process of Extrovert-Introverted Students in Solving the Contextual Mathematics Problem

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*Abstract-*This study is set to investigate mathematical communication process of students in solving contextual mathematics problem. It focuses on analyzing mathematical communication process of students with an Extrovert and Introvert personality based on solving problem phase of Polya. It is qualitative research with a case study strategy. Subjects are Tenth grade students selected by a snowball sampling. Before selecting the subjects, the researchers provide questionnaire of personality types to classify students with an Extrovert and Introvert personality. Then, the subjects are given a test of contextual mathematics problems to investigate their mathematical communication process. The results reveal thatin the understanding problem, introvert students are very good at showing symbolic communication. While the extrovert students do not show symbolic communication well. In the phase of executing the plan, extrovert students show logic communication in solving the problem. It can be seen from their way in elaborating the calculation logically and systematically.Meanwhile, introvert students do not show a good logic communication because they still face difficulty in finding solution and the calculation. In the phase of reviewing, introvert students show verbal communication in giving conclusion. However, extrovert students do not show verbal communication in solving the problem.

Keywords: Mathematical communication, problem solving, extrovert-introvert

1. Introduction

One of the significant abilities in facing the challenges of the 21st century is communication skill. It serves as the key to dealing with the paradigm shift of the 21st century. It completes other skills, such as collaboration skill, critical thinking, and creativity. Therefore, having communication skill is very important for every individual in order to develop their future skill. It is in line with a statement [1] that strategic skills are needed to pursue the success of life, such as learning and innovation skill which consist of critical thinking, communication, collaboration, and creativity.

Related to the statement, Mathematics is considered as a subject that is able to develop communication skills. As a statement reports that [2] learning mathematics can develop students' communication skills. Furthermore, [3] the objectives of mathematics learning, are: (1) learning to communicate (mathematical communication), (2) learning to think (mathematical reasoning), (3) learning to solve problems (mathematical problem solving), (4) learning to associate ideas (mathematical connections), (5) forming positive attitudes towards mathematics (positive attitudes toward mathematics). Thus, the objective confirms that mathematics is an appropriate tool to enhance one's communication skill.

In relation to the statement,[4] argues that mathematical communication skill is the ability of students to express ideas, describe, and discuss mathematical concepts in a coherent andclear manner. Another opinion stated by Walk *at al* [5] that the use of mathematical language helps students gain insight into their own thinking, develops and expresses their mathematics ideas and strategies precisely and coherently.

Related to that, [6] it can be concluded that communication must be part of a balanced mathematical program. It enables students to communicate mathematics ideas verbally and in writing, and evaluate their own thoughts and those of others. Having good written and oral mathematical communication skillwill trigger interaction among students, students with teachers, and the creation of other skills in mathematics learning.

Furthermore, [7] states that students can improve vocabulary, develop speaking skill, write down ideas systematically and have better learning skill through communication. Based on this, mathematical communication is one of the skills that will help students to solve mathematics problems. Students will be able to express their own ideas in solving mathematicsproblems by themselves through these skills. In fact, there are communication problems faced by the students. They have difficulty in explaining the solution of the problems [8]. Another fact states that students' communication in the form of spoken and written is low [9].

In principle, mathematical communication is usually realized through story case. In the process, the students are required to be able to turn mathematics sentences into mathematics symbols. Based on this reason, mathematical communication skill is very important for students to solve mathematics problems in the form of story case. However, the low level of interaction between students and teacher is a cause of the low level of students' mathematical communication. Therefore, the teacher must help students to express their mathematical ideas to the other [10].

Thus, it will add to their experience in conveying their mathematics thoughts to others. This is in accordance with the opinion of Chapin et al. [11] that children often show difficulty in presenting their mathematics thoughts to others or their mathematics thinking is not reflected in words. This is because of the lack of experience in communicating and presenting their mathematics thoughts to others.

Besides, Chrysostomou states that there are many factors affected students' ability in solving problems, such as intelligence, logical thinking skill, creativity and cognitive style, personality, values, attitudes and interests [12]. Based on this, personality affects solving problem process in mathematics. Therefore, the researchersfocus this study on Extrovert-Introverted personality. According to Eysenck [13], personality is divided into two, namely introvert and extrovert. Extrovert is individual who has some characteristics, such as likes to get along with, likes to party, has lots of friends, needs friends to talk to, does not like to read and study alone, desperately needs excitement, behaves without thinking, usually obeys conscience, loves to joke, always ready to answer, and usually likes change, does not need much consideration, and cannot always be trusted. While introvert personality has special characteristics among others, such as quiet, shy, introspective, bookworm, alone-lover, full of suspicion, dislike of excitement, a well-organized lifestyle, feelings of closure, pessimism in some ways, and high ethical standards.

The objective of the research is to describe written mathematical communication to the tenth grade students who have introvert and extrovert personality in solving mathematics contextual problem.

A. *Written Communication*

Written Communication Written communication is an individual way to explain in detail certain mathematical ideas [14]. Written communication can be interpreted in various ways: symbols (numerical and symbolic algebra), diagrams, graphs, or tables [15].

Written mathematical communication makes students easier to express their thoughts in explaining strategies, increasing their knowledge, writing logarithms, and improving cognitive abilities [16]. Communication facilitates students to express and explain reasons, and correct their thought processes and solutions in writing [17].

B. *Contextual Problem Solving*

According to [18] in solving problems, a person needs to go through several processes including: understanding the problem, compiling a completion plan, implementing the plan, and re-examining the results. [19] states that solving contextual mathematical problems can stimulate students to develop all psychological potential possessed specifically related to the process. This is because the use of contextual mathematics problems allows students to develop more complex thinking patterns by involving formal and informal mathematical knowledge.

In this study, what will be seen is students' written mathematical communication, namely how students can express mathematical ideas in a logical and clear manner, how students interpret and evaluate mathematical ideas in writing, and how students use terms, symbols, and structures to model mathematical situations or problems. The elaboration of communication aspects that are seen are logical communication, symbolic communication, and verbal communication. Logical communication is how students write steps to solve problems correctly and logically. Symbolic communication is how students understand and are able to use symbols and rules in mathematics appropriately. Symbolic communication can also be in the form of examples or modeling done by students to facilitate problem solving. Verbal communication is how students use words in providing reasons and conclusions from the results of problem solving.

2. Research Method

The type of research is qualitative research. The purpose of this study is to describe the process of mathematical communication of extroverted and introverted students in class X SMK PGRI Karangmalang in solving contextual mathematics problems. The technique in taking the subject is Snowball sampling. In this study, there are two types of instruments to collect data. The first is the researcher itself as the main instrument and the second is the supporting instrument in the form of worksheets, and unstructured interview guidelines. Data are analyzed based on written tests and interviews. The worksheet consists of the following questions: 1) Desti buys 4 rulers and 2 erasers at a stationery shop for Rp. 10,000. If Desti returns to buy 3 rulers and 2 erasers at the same shop for Rp. 8,000. So what is the price of 5 rulers and 5 erasers if Desti buys back at the store? Data collected and analyzed based on Miles and Huberman's theory with the following steps: 1) Data reduction consists of the selection process, the simplification process, and then extracting and changing the raw data; 2) Display data by classifying and identifying data until the data is organized; 3) Conclusions based on results. After that, the researcher applies the triangulation method to obtain valid data.

3. Results and Discussion

Based on the data analysis, the results and discussion of the mathematical communication process of students who have extrovert and introvert personality in solving contextual mathematical problems based on the Polya's problem-solving phase are obtained.

3.1. The Phase of Understanding Problem

The results of this study indicate that at the phase of understanding the problem, introvert students are very good at reading and writing the stated and asked information about the task.Theyare also able to use the appropriate notation. It can be seen from the results of the tests, theywritedownall the stated information completely and precisely. While extrovert students still do not write down the stated information in detail. It will greatly affect the success of students in preparing a completion of the next phase. After clarifying this matter, the subjects report that they do not pay attention to the stated information in detail. They tend to be hasty in reading the information.Therefore, in this phase, the introvert students have a good symbolic communication. While, the extrovert students have low level of symbolic communication.

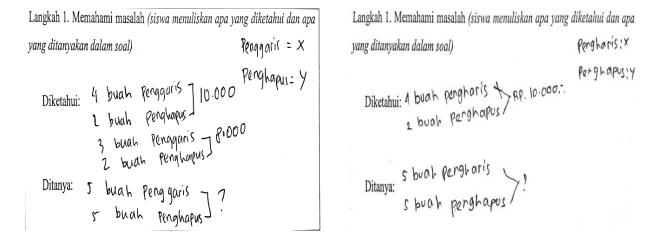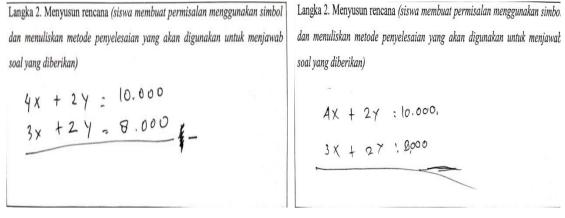Phase 1. Understanding the problem (the students write down the stated and asked information about the task)

Langkah 1. Memahami masalah *(siswa menuliskan apa yang diketahui dan apa yang ditanyakan dalam soal)*

Penggaris = X

Penghapus = y

Diketahui: 4 buah Penggaris] 10.000
1 buah Penghapus]

3 buah Penggaris] 8.000
2 buah Penghapus]

Ditanya: 5 buah Penggaris] ?
5 buah Penghapus]

Langkah 1. Memahami masalah *(siswa menuliskan apa yang diketahui dan apa yang ditanyakan dalam soal)*

Pengharis: X

Penghapus: y

Diketahui: 4 buah pengharis ⟩ RP. 10.000,-
2 buah penghapus ⟩

Ditanya: 5 buah pengharis ⟩ ?
5 buah penghapus ⟩

Figure 1.The answer of introvert students   Figure 2. The answer of extrovert students

3.2. The Phase of Developing Plan

The results of this study indicate that at the stage of implementing the plan, extrovert students do not need a long time to determine the strategy or step of completion, but when it is clarified about the equation "3x + 2y = 8,000", the subjects explained that it originated from the question. However, they are still hesitant and confused to solve the two equations, they are also still having difficulty in determining the sign (+) or (-) to solve the equation. For introvert students, they are indeed quite hesitant to choose the strategy that will be used in solving the problem so that they take a long time to draw a conclusion. However, they are able to understand the steps that they will take to find a solution. When the subjects are asked to determine the value of 'x" or "y", they answer quite convincingly so that it is the reason for them to reduce the two equations. This is chosen to make them easier to describe the steps to resolve the problem.Therefore, the introvert students show a good symbolic communication, whereas the extrovert students do not show a good symbolic communication.

Phase 2. Developing plan (the students change the form of stated information into a symbol and write down completion method to answer the task
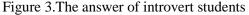
Langka 2. Menyusun rencana *(siswa membuat permisalan menggunakan simbol dan menuliskan metode penyelesaian yang akan digunakan untuk menjawab soal yang diberikan)*

$4x + 2y = 10.000$
$3x + 2y = 8.000$ { $-$

Langka 2. Menyusun rencana *(siswa membuat permisalan menggunakan simbo. dan menuliskan metode penyelesaian yang akan digunakan untuk menjawak soal yang diberikan)*

$4x + 2y = 10.000,$
$3x + 2y = 8000$

Figure 3.The answer of introvert students   Figure 4. The answer of extrovert students

3.3. The Phase of Implementing Plan

The results of this study indicate that at the stage of implementing the plan, introvert students are not too difficult in describing the steps of completion.They are able to explain and describe the calculation logically and systematically. In fact, they are able to understand the mathematical rules that they have been used in the settlement, and then they find the value of "x" and "y" exactly. Moreover, extrovert students have difficulty in finding a solution to the strategy that they have been planned because they are still hesitant to determine the value "x" or "y". As a result, they takea long time to determine the operation to find the solution. In addition, the results of the calculation are still not right. This is because the subjects still do not understand the mathematics rules in solving these mathematics problems.Therefore, in this phase, the introvert students have a good logical communication. It is different from extrovert students who do not show a good logical communication.

Phase 3. Implementing plan (the students employ completion method/strategy to answer the task.

Figure 5.The answer of introvert studentsFigure 6. The answer of extrovert students

3.4 The Phase of Reviewing

Based on the results of this study, it is shown that at the re-examination phase, introvert students are able to conclude the results of their completion using their own language. In fact, they are able to explain the asked information about the task in detail. The subjects are able to re-explain the notation of calculation into the real object that is asked in the task. Thus, after checking all of the phases, the introvert subjects feel very confident that the solution is correct. Meanwhile, extrovert students do not write any conclusion of the task because they are not sure of the calculation results that they have been done in the previous phase. After checking all of the phases, they feel that there is something wrong with their answer so that they still cannot give any conclusion from the results of their work.Therefore, in this phase, the introvert students show a good verbal communication. It is different from the extrovert students who do not show verbal communication in solving the problem.

Phase 4. Reviewing (the students draw a conclusion and find the answer of the task)

Langka 4. Melihat kembali *(siswa membuat kesimpulan dari hasil yang diperoleh dan menemukan jawaban dari pertanyaan dari soal)*

S Penggaris $= 5X$ dan S Penghapus $= 5Y$

Jadi, $5X + 5Y$

$\Rightarrow 5 \times 2000 + 5 \times 1000$

$= 10.000 + 5.000$

$= 15.000$

Jadi harga 5 Penggaris dan 5 Penghapus adalah Rp 15.000

Langka 4. Melihat kembali *(siswa membuat kesimpulan dari hasil yang diperoleh dan menemukan jawaban dari pertanyaan dari soal)*

Figure 7.The answer of introvert studentsFigure 8. The answer of extrovert students

4. Conclusion

Based on the results and discussion, it can be concluded that at the stage of understanding the problem, the introvert students show a good symbolic communication, while the extrovert students still do not show a good symbolic communication. It can be seen from the results of the work of the introvert students who are able to use notation in accordance with the problems. Conversely, the extrovert students still do not write down the information of the problem completely. In the planning stage, the introvert students show a good symbolic communication, while the extrovert students do not

show a good symbolic communication in preparing the formula that will be used in solving the problem. At the stage of implementing the plan, the introvert students show logical communication, while the extrovert students do not show logical communication in answering questions with the planned formula. It is seen that the introvert students are able to explain and describe their calculations logically and systematically. Meanwhile, the extrovert students still have difficulty in finding solutions to the strategies they have planned, even the calculation results that they have obtained are still not quite right. In the reviewing stage, the introvert students show verbal communication well in providing conclusions from solving the problem, while the extrovert students do not show verbal communication in concluding the results obtained in the previous stage. It is seen that the introvert students are able to deduce the results of their completion well using their own language. While the extrovert students do not write down conclusions from these problems.

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