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The Tenth Grade Vocational Students' Mathematical Communication Patterns based on Personality Types

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Abstract

The differences in individual's personality create diversity in communication. This study is aimed to describe the students' written mathematical communication patterns based on personality types. It is a qualitative descriptive study in X grade vocational high school students of SMK N Tengaran, Semarang Regency in 2019/2020. The data were obtained by documenting the results of students' mathematical communication tests and interviews. The research findings show that there is no unique pattern for each personality type in the mathematical communication patterns associated with sequence of working on questions. However, in mathematical communication patterns that are related to the type of error performed, the Introvert - Neurotic personality type makes the most types of errors in using incorrect variables and calculation errors.

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INTRODUCTION

Gerbner (1980) says that communication is social interaction through symbols and systems of conveying messages from one to another so that mutual understanding achieved. Another definition is stated by Abdulhak and Darmawan (2013) that communication is a process of delivering messages from sender to recipient with certain media and goals.

As a way of sharing ideas and clarifying understanding, communication takes an important part to support the success of students learning. According to Baroody (1993), there are at least two important reasons to make communication in mathematics learning as a focus of attention, namely (1) mathematics as language; mathematics is not only a tool for thinking, for finding patterns, or solving problems, but mathematics is also a tool for conveying ideas accurately and clearly; and (2) mathematics learning as social activity ; as a social activity, both interaction between students and teacher-student in mathematics learning has an significant role of managing students' potential on mathematics. These consideration makes communication - in this case the mathematical communication - become one of the standards process in the mathematic learning formulated by the National Council of Teachers of Mathematics (NCTM), in addition to problem solving, reasoning, mathematical connection, and mathematical representation.

Among five standard processes set
NCTM, mathematical communication has a strategic role in supporting the other standard mathematical processes. Clark (2005) states that mathematical communication is a way of sharing ideas and clarifying understanding. Ideas can be reflected, improved, discussed and developed through communication. Another opinion come to Atkins (1999) that mathematical communication is " a tool for measuring growth in understanding, allow participants to learn about the mathematical constructions from others, and give participants opportunities to reflect on their own mathematical understandings ". Communication process also helps build meaning and explores ideas as well as explains those ideas. When students in a small group are challenged about their thoughts and thinking skills to the mathematical problems presented, in essence, they are communicating the results of their thoughts orally or written, in addition to learn to explain and convince. Communication is a person's ability to connect messages either by reading, listening, asking questions, then communicating the location of the problem and presenting it in order to solve a problem.

In the communication process, there is a reciprocal relationship between sender and recipient of the message. There are many factors that influence the communication process; one of them is emotion (Potter and Perry, 2007). Understanding emotional conditions will certainly require an understanding of personality.

Personality is a personal charactistic which trigger consistency feeling, thought, and behaviour (Pervin et al., 2010). Hans Jurgen Eysenck formulates his personality theory and combines it into personality dimensions (i.e. extrovert and introvert) and emotional dimension (i.e. neurotic and stable). The personality dimension refers to the personality tendency in dealing with certain situations. Meanwhile, the emotional dimension refers to the level and ability to control emotions.

Introverts tend to be calm, shy, aloof, introspective, prefer books to talking, keep their distance except from close friends, are full of concern and rarely act aggressively (Eysenck, 1970). Therefore, introverted tend to learn more effective in individual and require more free situations. Extroverts tend to be good at socializing, have lots of friends, need people to talk to, dislike reading and studying on their own, inconstant and are usually impulsive. Therefore, extroverted learn more effective through contact with the outside world and connect with other people. They will feel more energized when they are with other people and interacting with them, and can often express their best ideas if they can share them with others.

Mathematical communication skills
are divided into two, namely written and oral. Oral mathematical communication skills are related to the ability to describe the idea of mathematical in order to convey and explain in detail to others. Meanwhile, written mathematical communication skills are related to the ability to express, demonstrate

mathematical ideas through writing, and describe them visually.

In relation to each character of personality type, it implies that there is a close relationship between oral mathematical communication skills with the personality type of students. However, whether personality type is also related to written mathematical communication skills is what will be explored in this study.

METHODS

It is a qualitative descriptive study. In the pre-research stage, personality types were categorized using the Eysenck Personality Inventory (EPI) (Eysenck, 1970). This personality theory combines the dimensions Extraversion (E) and Neuroticism (N). The E dimension confirms an individual's tendency to certain social situations while the N dimension confirms whether an individual is unstable, easily aroused, sensitive, and anxious.

In the E dimension, a maximum score of 12 is categorized as introverted, while a minimum score of 13 is categorized as extroverted. In the N dimension, a maximum score of 12 is categorized as stable, while a minimum score of 13 is categorized as neurotic. From both dimensions, it is gained classification of personality type of Eysenck (1970) which consists of Extrovert Stable (ES), Neurotic Extrovert (EN), Introvert Stable (IS), and Introvert Neurotic (IN).

Extroverted - Neurotics tend to be active, optimistic, impulsive, inconstant, excited, aggressive, restless, and irritable. Extroverted - Stable tends to be sociable, friendly, talkative, disruptive, passionate, not thoughtful and has leadership traits. Introverted - Neurotics tend to be moody, anxious, clumsy, simple, aloof, less sociable, and quiet. Meanwhile, Introverted - Stable is passive, careful, wise, peaceful, self-controlled, trustworthy, and calm (Eysenck, 1970). Despite having opposite characters, introverts and extroverts basically do not have a significant difference in ability in mathematics (Igbojinwaekwu, 2009; Chinelo, 2016). From the results of personality type categorization, the research subjects were determined by purposive sampling which the research subjects are selected based on the research objectives or certain considerations (Satori and Komariyah, 2017).

There are two types of questions based on the possible number of answers of a question, namely close-ended questions and open-ended questions (Kwon, Park, and Park, 2006; Nohda, 2000). Close-ended questions are questions that require a single answer in terms of both the single solution and the single way to answer. On the other hand, open-ended questions are questions that have many solutions or open opportunities to use a variety of completion strategies (Takahashi, 2006). The data in this study were taken using two techniques namely documentation techniques with instruments in the form of open-ended and close-ended items and interview techniques to confirm documented students' works.

Mathematical communication patterns are viewed from two aspects. The first is based on how to communicate the solution to the questions presented, whether it is 1) coherent and complete according to the sequence of stages commonly used in solving questions, namely starting from the stage of understanding the problem, carrying out problem solving procedures and interpreting the results obtained; 2) coherent but incomplete (cutted off); 3) not coherent but complete (skipped); and 4) not coherent at once incomplete (incomprehensible). The second is based on the various mistakes that have been made. Newman (1983) states that the steps for solving the problem include the following steps include (1) decoding, (2) comprehension, (3) transformation, (4) process skills, and (5) encoding. From these stages, it is developed to categorize the various errors of the answer to an essay test. Errors in decoding steps are errors that occur because students cannot recognize or read the terms in the question, do not recognize symbols or do not know what the questions are asking. Comprehension stage errors are errors resulting from not understanding terms, phrases or not knowing the question comprehensively. Error transformation is an error that is caused by students inability to change the information in question to mathematical symbols, operations and mathematical sentence correctly. Refers to mathematical indicators communication, it belongs to inability to use terms, the notation of mathematics and its structures to presents ideas, describes relationships and situation models . Errors in process skills is an error in applying the calculation

correctly. An error in the encoding stage is an error caused because students are unable to interpret the calculation results obtained in accordance with the questions.

The technical analysis in this study refers to the opinion of Miles and Huberman, namely data reduction, data presentation, and drawing conclusions (Sugiyono, 2013). Meanwhile, the validity of data in qualitative research is determined using four criteria, namely the trust test, transferability, dependence, and certainty (Moleong, 2013).

RESULTS AND DISCUSSIONS

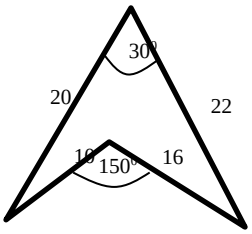
Mathematical communication patterns are viewed from two aspects, namely based on how to communicate solutions to the problems presented and based on the various errors that have been made. The items used in this research are divided into two types: close-ended questions and open-ended questions. There are 9 items of question, consists of 5 close-ended items and 4 open-ended items. Close-ended questions can only be solved with one solution strategy with results in one solution. The open-ended question is question with a single solution, but it opens up opportunities to use a variety of solving strategies. Not all students answer all the questions given.

Based on the way to communicate the solutions to the questions presented, it is used close-ended one with 32 students' works were analysed as presented in the following dat

Table 1. Distribution of ways of communicating solutions to close-ended questions

Number of Question	**How to communicate a solution**	**Personality type**			
		ES	EN	IS	IN
1	Coherent	2	1	2	3
	Cutted off		1	1	1
	Skipped				
	Incomprehensible	2	2	1	
	No answer	7	4	1	4
5	Coherent		1	3	1
	Cutted off	1	1	1	1
	Skipped				
	Incomprehensible			1	2
	No answer	10	6		4
6	Coherent	2	2	1	1
	Cutted off	3	1	2	2
	Skipped				
	Incomprehensible				
	No answer	6	5	2	5
7	Coherent			1	
	Cutted off	5		2	1
	Skipped				
	Incomprehensible	3	3	1	4
	No answer	3	5	1	3
9	Coherent	1	3	1	2
	Cutted off	3		1	
	Skipped				
	Incomprehensible	1			
	No answer	7	5	3	6

From the results in the Table 1, it can be seen that the sequence of working on skipped questions is not found in the answers of close-ended questions. In the other three sequences, the usage does not form a certain distinctive pattern. For a coherent way, even though there are many variations of errors, the sequence of working on question for each personality is relatively the same in general, starting from drawing illustrations (if needed), calculating a measure with certain variables, choosing the appropriate concept, and solving it. Even for answers with the wrong choice of concept, the process is still in order. For instance is in the following answer of close-ended question.



Pay attention to the figure. What is the area?

IS (E35)

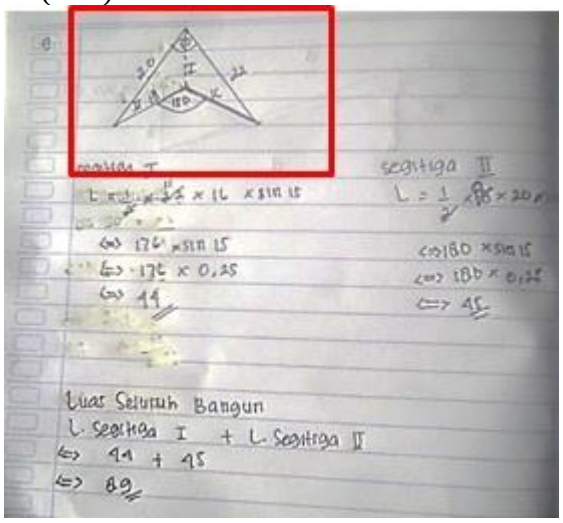


Figure 1. Examples of student work with a coherent way on close-endedd questions

In the Figure 1, it can be seen that even though students make mistakes in capturing mathematical ideas on the problem, the workflow is coherent and complete.

For the cutted-off, sequence of working on question runs partially. The stoppage parts do vary among students. However, this variation does not converge on a certain personality type, it common occurs in each personality type. The most obvious example of a cutted-off answer is in following answer of close-ended question.

Find the result of sin 100^0 + sin 110^0 + sin 120^0 + … + sin 270^0

ES (E28)

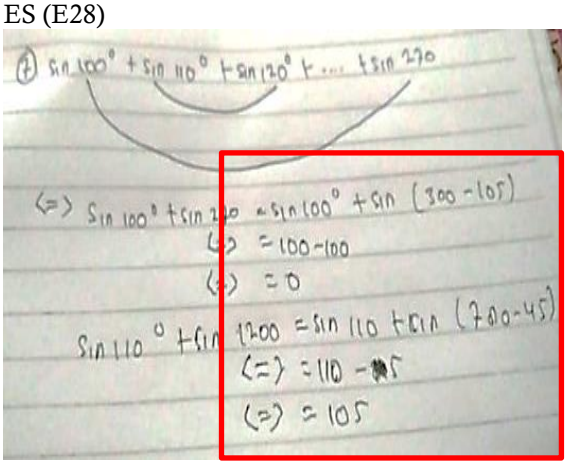


Figure 2. Examples of student work with cutted off sequence in close-ended questions

Figure 2 shown that the students have taken the initiative to 'pair' the related angles, but unfortunately the process was not properly executed, because the majority of steps taken just exactly operate at angle value.

Incomplete and incoherent sequences are most commonly found in following answer of close-ended question.

If p exists in a right triangle, the length of the front edges of the angle α is $\frac{1}{3}x$ and the hypotenuse of the angle α and x, then the value of $\tan\alpha = \frac{2}{3}\sqrt{3}$, is this statement correct?

EN (E1)

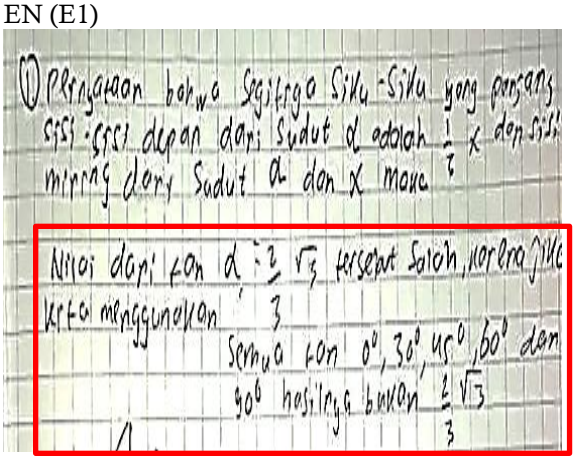


Figure 3.Examples of student work with an incomprehensible sequence

Although the answers are vary, in general the way to answer as in the Figure 3 occurs for each personality type. The emerged contradiction samples are not relevant to the context of the question being discussed.

For close-ended question, from the 32 students' works, the distribution of mathematical communication patterns is captured in Table 2

Table 2. Distribution of ways of communicating solutions to open-ended questions

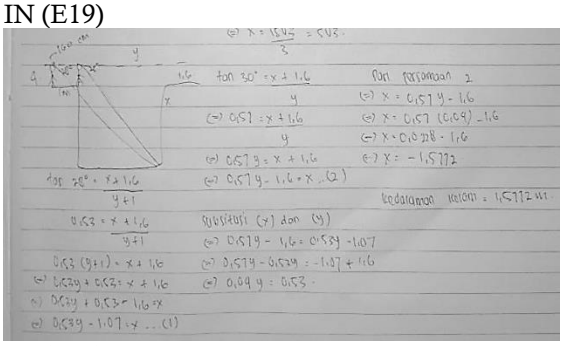
Number of Question	Mathematical Communication Patterns	Personality type			
		ES	EN	IS	IN
2	Coherent	5	4	4	4
	Cutted off	4	2	1	3
	Skipped				
	Incomprehensible	1	1		1
	No answer	1	1		
3	Coherent	8	7	4	6
	Cutted off	2	1	1	2
	Skipped				
	Incomprehensible				
	No answer	1			
4	Coherent	8	7	4	5
	Cutted off				
	Skipped				
	Incomprehensible	1		1	1
	No answer	2	1	1	2
8	Coherent	1	1	1	2
	Cutted off	5	1		
	Skipped				
	Incomprehensible		1	2	3
	No answer	5	5	2	3

The aspect of openness in the tested items in this study is openness in terms of how to solve it. This openness turns out to make different the students responses in communicating their answers. The skipped sequence that was not previously found in the answers to close-end questions was found in the answers to open-ended questions. Nevertheless, same as with the previous findings, the use of four sequences does not form a certain distinctive patterns based on personality type.

For a coherent way, the sequence of working on found in each personality are relatively the same, even for answers with different concept choices as in the following answer to open ended question.

Someone wants to measure the depth of a pond without water. However, he could not measure the length of the pond because of the impossible terrain. At this time, he could see the bottom of the pool with a depression angle of 30 ^{0}. As he retreated 1 m away, he could see the bottom of the pool with a depression angle of 28 ^{0}. If the observer's height 160 cm, how is the way to measure the depth of the pond?

IN (E19)



ES (E30)

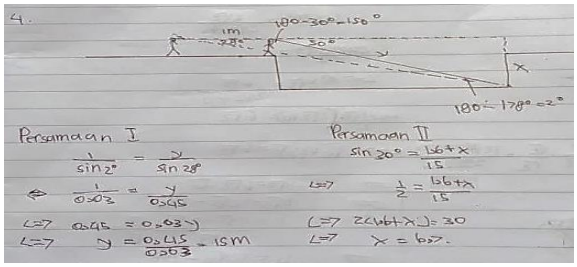


Figure 4. Examples of student work with a coherent sequence on open-ended questions

The concept used by E19 is also used by majority students. However, even though the E30 uses different concepts to answer the question, the sequence of work remains the same, i.e. starting from drawing illustrations (if needed), calculating a measure with certain variables, choosing the appropriate concept, and solving it.

As well for the cutted off sequence, the process of working on questions that only runs partially does vary among students. However, there is no conical sequence pattern found to certain personality types. In question of figure 4, there were many students who had written two equations from the illustrations they made. Some have stopped to the equation; some have been substituted but are not finished.

The skipped sequences are mostly found in the following answer of open ended question.

What is the value of x?

IS (E21)

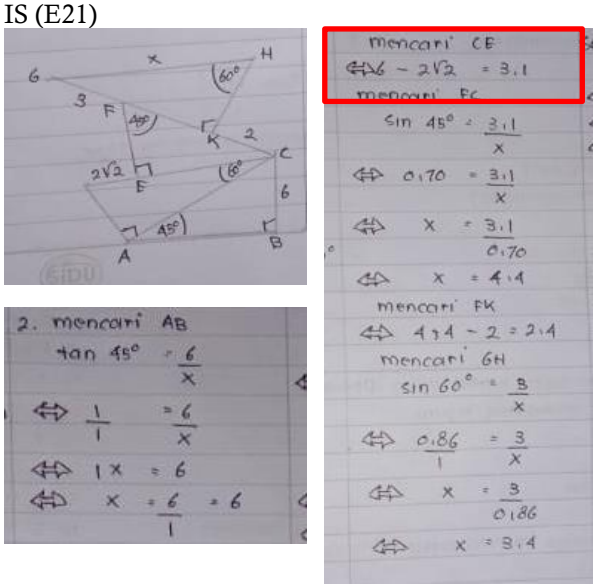


Figure 5. Examples of student work with a skipping sequence

In the Figure 5, students actually understand that to determine the length of the GH side, they must start looking for CE and FC first. The problem is in process of searching for length of CE. They suddenly write that length of CE = $6 - 2\sqrt{2}$, whereas the previous process just exactly find AB.

In incomplete and incoherent sequence, there are no distinctive patterns found in certain personality types as well. Making incomprehensible illustrations as prevalent in question number 8 are also carried out by learners with different personality types.

From those findings, it shows that the communication patterns in relation to the working sequence are not found typical patterns between personality types. However, if it is viewed from the type of mistake, distinctiove patterns are found in Introvert-Neurotic students.

Five types of errors according to Newman (1983) consists of errors in the decoding, comprehension, transformation, process skills and encoding stages were found in all personality types. However, specifically to the type of errors at the transformation stage and the process skill, mostly made by Introvert Neurotic students. Errors at the skill process stage include errors in doing calculations. The most mistakes in the transformation stage are mistakes in using variables. For example is in the following answer of open ended question.

A river flows from west to east. A man, where is on the south side of the river, stands in front of a large rock across the river. If he moves westward for 9 m, he must rotate his body 300m to the right to look at the same rock. How wide is the river?

IN (E17)

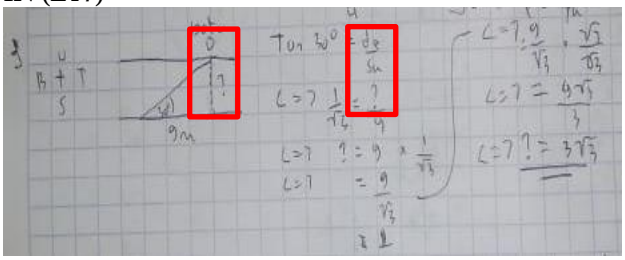


Figure 6. Examples of mistakes made by Introverted - Neurotic students

In this question, the error of the transformation type was the use of an incorrect variable, for example by using '? ' to assume the width of the river. The mistakes in the Figure 6 are actually also found in other personality groups. It is just exactly that most

of mistakes found in the Introvert-Neurotic group, in some cases it occurred in more than 50% of Introvert-Neurotic students' works. After taking in depth interview, it was obtained that the mistakes were mostly caused by the typical character of the Introvert Neurotic individual; they tended to get easily anxious when facing a stressful conditions such as during a test.

CONCLUSION

The results shows that the mathematical communication patterns in relation to working seuquence in close-ended questions included coherent, cutted off, and incomplete incoherent. Meanwhile, the working sequence in open-ended questions includes coherent, cutted off, and incomplete incoherent.

However, the use of each pattern not turn out to be confined to certain personality types. Typical patterns appear in mathematical communication patterns in relation to the types of errors performed. The types of errors made by Extrovert - Stable, Introvert - Stable, and Introvert - Neurotic students are various and do not form a certain pattern. However Introvert - Neurotic students make errors mostly in using incorrect variables and calculation errors.

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