ANALYSIS OF MATHEMATICAL COMMUNICATION ABILITY THROUGH 4K MODEL BASED ON 7th GRADERS' PERSONALITY TYPES

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Abstract

The purpose of this research is obtain a description of mathematical communication ability (MCA) through 4K learning model based on personality types Guardian, Artisan, Rational, and Idealist. The subjects of this research consist of 4 students 7th grade in State Junior High School 2 Semarang. The techniques to collect data of this research are mathematical communication test and interviews. Test result and interviews are analyzed based on the mathematical communication ability criteria, they are the ability of: (1) writing what are known and what are asked (MCA 1); (2) writing an answer appropriate with the problem intention (MCA 2); (3) writing the reason in problem solving (MCA 3); (4) making a sketch related to problem (MCA 4); (5) writing the technical terms and mathematics symbols (MCA 5); and (6) writing a conclusion with own words (MCA 6). The result of this research showed that: (1) Guardian master MCA1, 2, 3, 4, and 5, but does not master MCA 6; (2) Artisan master MCA 1, 2, 3, and 4, but does not master MCA 5 and 6; (3) Rational master all MCAs; (4) Idealist master MCA 1, 2, and 4, but does not master MCA 3, 5, and 6.

Keywords: Mathematical Communication, 4K Model, Personality Types

1. INTRODUCTION

Mathematics is science about well organized structure (Satoto, 2012). Mathematics is full of emblems and symbols which high mathematical understanding is needed to understand it. Huggins in Qohar (2011) argued that in order to improve conceptual understanding mathematically, is to express mathematical ideas to others. Ability of expressing mathematical ideas to others both orally and in writing is called mathematical communication. Students' mathematical communication reflect how far the students' mathematical understanding and their misconceptions (NCTM, 2000). Therefore, it is important for teachers to know the mathematical communication of students in a mathematics learning. By knowing the mathematical communication of students, teachers can investigate how far the the students' mathematical understanding and their misconceptions. Teachers can use misconceptions as reference material resources in choosing appropriate learning model with students so that they can study.

A learning model can be appropriate with a student, but it cannot be appropriate with others. It happens because of the fact that every student is a unique individual who has different characteristic. The differences must be accepted and utilized by teacher in learning. As Hardini &

Puspitasari (2012) who said that a teacher must pay attention the students' characteristic in choosing precise learning strategy (including approach, model, method, and specific learning technique). Many factors influence these differences, one of which is their personality. Personality is the characteristic of the person who caused the emergence of consistency juice, thinking, and behavior (Pervin *et al*., 2010). Keirsey (1998) classify personality into four types, namely Guardian, Artisan, Rational, and Idealist. Each personality type has the uniqueness of each. In terms of communication, Keirsey (1998) classifies Artisan and Guardian as a concrete communicator, while Rational and Idealist as an abstract communicator. Concrete Communicators prefer to talk and write about reality, whereas abstract communicators prefer to talk and write about ideas. Concrete communicators like facts, figures, evidence, while abstract communicators like theories and hypotheses.

Be guided by the differences of personality and the students' communication way, then the teacher can provide the best learning model for each individual student. Learning model can be given based on a misconception and students' mathematical understanding that are reflected in students' mathematical communication. In order to achieve this, the researchers analyzed the mathematical communication of students based on personality type Guardian, Artisan, Rational, and Idealist. Researcher requires subject research with good communication to facilitate researcher in analyzing mathematical communication of students. To obtain students with good mathematical communication, it takes a learning model that can explore students' mathematical communication.

A learning model that can explore students' mathematical communication is a model that is able to develop and explore aspects of the communication. Baroody in Qohar (2011) suggested that there are five communication aspects, namely: (1) representing, (2) listening, (3) reading, (4) discussing, and (5) writing. But in the mathematics curriculum standards NCTM (2000), the ability of the mathematical representation is no longer included in the communication but became one of the distinctive capabilities that also need to be developed in mathematics. Therefore, aspects of communication are no longer containing representations.

One model of learning that can give students the opportunity to develop and explore aspects of optimal communication is the 4K learning model. Masrukan *et al.* (2014) suggested that the syntax 4K learning model includes six phases: (1) illustration of character development that provides an illustration, story, or film that can develop the character of students in accordance with the subject to be studied; (2) investigations that involve students in the investigation of the mathematics characteristics using teaching aids made from recycled materials relating to specific mathematical concepts or principles; (3) collaborative exploration is to give students the opportunity to explore collaboratively in order to rediscover the concepts and principles of mathematics with simple teaching aids helping; (4) creative performance that provides greater opportunities for students to produce mathematical product creatively; (5) communication that gives students the opportunity to expose (exposure/exhibition) mathematical products; and (6) the appreciation is based on criteria for selecting the best group: truth, creativity, and appearance.

The implementation of each phase of the 4K learning model is expected to explore aspects of communication so that produce students with good mathematical communication. In the illustration of character development phase, students are required to be able to listen teacher

explanations well. In the investigation phase, students are given the opportunity to ask and argue that can construct their understanding well. In the collaborative exploration phase, students are trained to improve their discussion. In a phase of creative performance, students can train themselves to write about mathematics (writing) because in this phase the teacher can ask the students complete the math problems in writing. Communication phase can be used by teachers to train the ability to read (reading) of students because they can read and present the results of their discussions. In the appreciation phase teacher can give awards to students or groups with best mathematical communication ability so that they are motivated to try to maintain and even improve their mathematical communication ability.

In order that teacher can choose learning model which appropriate with students individually, then this research analyzes students' mathematical communication based on personality type Guardian, Artisan, Rational, and Idealist. To facilitate researchers in analyzing students' mathematical communication, this research conducted mathematics learning using 4K learning model so that it's expected can develop and explore students' mathematical communication ability optimally.

Silver *et al.* (Kosko & Wilkins, 2012) expressed written mathematical communication ability are considered more capable of helping people to think about and explain in detail about an idea. Jordak *et al.* (Kosko & Wilkins, 2012) added that written mathematical communication ability will help students to express their thinking in explaining the strategy, increase their knowledge in writing algorithms, and generally to improve cognitive abilities. Therefore, the mathematical communication ability in this research is written mathematical communication ability.

Based on the description, researcher conducted a research entitled "Analysis of Mathematical Communication Ability Through 4K Model Based on 7th Graders' Personality Types".

2. METHOD

The method used in this study is a qualitative method. Selection of qualitative method is based on the goal of researcher who wished to express analysis of students' mathematical communication based on their personality types according to Keirsey, the type Guardian, Artisan, Rational, and Idealist deeply.

Subject researches in this study consisted of four students of class 7th G State Junior High School 2 Semarang. Selection of class 7th G as a class subject based on good communication ability in classical mathematical. Four subjects of the study consisted of a student personality type Guardian, Artisan, Rational, and Idealist where to find their personality type, researcher spread questionnaire classification of personality types. Selection of research subjects is based on the consideration of teachers and researcher by paying attention to the following criteria: (1) the personality type, (2) school report of odd semester, (3) the activity during the mathematics learning, and (4) expressing opinions ability orally and in writing.

Collecting data techniques in this research is mathematical communication test and interview. Results of tests and interviews were analyzed refers to the mathematical communication ability criteria (MCAC), they are the ability of: (1) writing what are known and what are asked

(MCA 1); (2) writing an answer appropriate with the problem intention (MCA 2); (3) writing the reason in problem solving (MCA 3); (4) making a sketch related to problem (MCA 4); (5) writing the technical terms and mathematics symbols (MCA 5); and (6) writing a conclusion with own words (MCA 6).

3. RESULT AND DISCUSSION

The personality types questionnaire respondents consisted of 29 students. Results of the personality type questionnaires showed that of 29 students, there are 6 students with Guardian personality type (concrete cooperators), 4 students with Artisan personality type (concrete utilitarians), 12 students with Rational personality type (abstract utilitarians), 6 students with Idealist personality type (abstract cooperators), and 1 student with multiple personality type that are Artisan and Idealist. The detail of the personality type questionnaire results is presented in Table 1.

From the Guardian students, Artisan students, Rational students, and the Idealist students, selected purposively subject research each type of as much as 1 students, they are S28, S7, S24, and S21 and the codes are changed into G, A, R, and I. Selection is based on the consideration of teachers and researcher by paying attention to the following criteria: (1) the personality type, (2) school report of odd semester, (3) the activity during the mathematics learning, and (4) expressing opinions ability orally and in writing.

Table 1. Instruments of Personality Type Questionnaire Results

No	Subject Code	Total Score				Personality Type
		A	I	G	R	
1	S1	42	37	40	41	I
2	S2	45	42	43	30	R
3	S3	40	41	33	46	G
4	S4	39	46	46	29	R
5	S5	53	39	38	30	R
6	S6	40	36	45	39	I
7	S7	27	40	39	54	A
8	S8	38	39	39	44	A
9	S9	53	39	42	26	R
10	S10	43	34	37	46	I
11	S11	42	41	49	28	R
12	S12	44	40	35	41	G
13	S13	29	39	41	51	A
14	S14	39	39	41	41	A dan I
15	S15	33	41	45	41	A
16	S16	48	34	40	38	I
17	S17	47	31	44	38	I
18	S18	50	45	29	36	G

No	Subject Code	Total Score				Personality Type
		A	I	G	R	
19	S19	47	39	42	33	R
20	S20	43	40	38	39	G
21	S21	38	35	43	44	I
22	S22	42	44	38	36	R
23	S23	33	49	46	32	R
24	S24	47	38	41	34	R
25	S25	48	41	39	32	R
26	S26	51	36	44	29	R
27	S27	43	39	35	43	G
28	S28	43	39	37	41	G
29	S29	43	41	40	36	R

Note:

A : Artisan Personality type

I : Idealist Personality type

G : Guardian Personality type

R : RationalPersonality type

After determining the subject research, the researcher implements the mathematics learning using 4K learning model. Based on observations of implementation taken from observations or classroom observation, analysis of photographs and video footage analysis study conducted gives the conclusion that the implementation of mathematics learning using 4K learning model performing well. Then the subject researches are asked to do the mathematical communication test that are consists of 3 questions for 40 minutes. Mathematical communication test of subject researches result is presented in Table 2.

Table 2 Results of Mathematical Communications Ability Test Subject G, A, R, and I

Subject	**CMC**																		**Total**
	1			**2**			**3**			**4**			**5**			**6**			
	Problem			**Problem**			**Problem**			**Problem**			**Problem**			**Problem**			
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	
G	4	4	4	4	3	4	4	4	1	4	3	4	4	4	4	4	1	1	61
A	4	4	4	4	4	4	4	4	4	4	3	4	2	2	4	3	3	4	65
R	4	4	4	4	4	4	4	4	1	4	4	4	3	3	4	4	4	4	67
I	4	4	4	4	4	3	1	4	1	4	4	3	4	2	4	2	2	3	57

After the subject researchs did the mathematical communication test, researcher conducted interviews with them. Results of triangulation of mathematical communications test and interview with the research subject indicate that the data are valid. Based on the results of tests and interviews, got that : (1) Subject Guardian mastered MCA 1, 2, 3, 4, and 5, but does not master MCA 6; (2)

Subject Artisan mastered MCA 1, 2, 3, and 4, but does not master MCA 5 and 6; (3) Subject Rational mastered all six MCAs, but has a tendency not to write down the reasons in answering questions; (4) Subject Idealist mastered MCA 1, 2, and 4, but does not master MCA 3, 5, and 6.

3.1 Discussion of Guardian Student Mathematical Communication Ability Analysis

Results of the Guardian mathematical communication ability analysis in accordance with the type Guardian described by Keirsey (1998). Subject G was able to write what are known and asked the three questions correctly and accurately. Subject G had no difficulty in finding information on the problem because the teacher had familiarized the students to write down what are known and asked in the problem through the exercises in each lesson designed by the researcher. Habituation is intended that the mathematical communication ability of Guardian student increased. It is based on Keirsey & Bates in Yuwono (2010) which suggested that Guardian students like repetition and drill in a receiving material, and a strong memory.

In general, the subject G was also able to write down the answers appropriate with the problem intention. Subject G also wrote down the reasons in answering problems 1 and 2, but did not write down reasons in answering problem 3 because G forgot to write it down. Subject G wrote down reasons in answer to questions by always writing down calculations without writing down the formula first. Subject G wrote empirically and specific answer. Empirically means the subject G directly utilize data from the known matter to answer the problem. Specifically subject G was no longer to write formulas in general, but directly substituting numbers into variables contained in the formula. Interview results also indicated that the subject G was used to writing down calculations directly without writing a formula in each time work on the problems. This is appropriate to the Keirsey (1998) which suggested that the Guardian as a concrete communicator likes speaking and writing empirically and specific.

Aside from being a concrete communicator, the subject G also showed the cooperative nature in making sketch related to the problem. The way subject G in drawing the same as most people. In answering the question of transformation, the subject G drew objects using a pen and drew a shadow using a pencil. On learning that is designed by the researcher, each group of students always draw by that way. They drew objects and shadows in different ways.

Subject G also had no difficulty in writing the terms and mathematical symbols. Although the Guardian prefers to speak and write something concrete, but the Guardian is very easy to learn if they were given repetition or drill exercises in which they can practice writing down terms and mathematical symbols. In this research, the researcher is designing learning in which students can practice mathematical communication ability.

In contrast to the ability of the subject G in writing the terms and mathematical symbols, subject G ability of making conclusions in writing using her language is too less. The interview result show that the subject G were able to make conclusions to the three questions, but only wrote conclusion on the first problem on the answer sheet. In the interview, subject G admitted that he was too dizzy to do the problems and the time allocation for taking the test was too short so that the subject G did not have time to write the conclusion.

3.2 Discussion of Artisan Student Mathematical Communication Ability Analysis

Results of the Artisan mathematical communication ability analysis in accordance with the type Artisan described by Keirsey (1998). The mathematical communication ability of subject A is good because in general the subject A mastered 4 of 6 MCA, namely MCA 1, 2, 3, and 4 very well. Results of the Artisan mathematical communication ability analysis of subject A is good obtained as 4K is learning model suitable for the Artisan students. Keirsey & Bates in Yuwono (2010) suggested that Artisan students really liked learning with a lot of demonstrations, discussions and presentations. In addition, Artisan students very like things related to arts and crafts that assessment products used in this study is very appropriate for the Artisan students. By learning that suits their personality, Artisan students will be easier to learn so that provide the good results that in this research is mathematical communication ability.

Beside the four MCAs subject A which showed good results, the ability of subject A to write down the terms and mathematics symbols in solving problem in general had also been good. This is shown by subject A who is able to write down the terms and symbols of mathematics in solving problem 1 and 3 correctly. Although basically the Artisan students as concrete communicators prefers words rather than symbols (Keirsey 1998), but the learning provided is in accordance with the Artisan students so that the subject A is easier to learn and understand the material presented. Subject A less precise in writing mathematical symbols in answer to question 2. Subject A was wrong in writing a map symbol and inverse transformation. At question 2, known as the triangle shadow of the triangle after transformed. Subject A write as the shadow of . This happens because at the beginning of learning, teachers introduce as the shadow of without confirmed the meaning of itself so that the subject A will be used to write the as the shadow of . In each meeting, the teacher is already introduced another symbol to symbolize the image of an object, but it is basically an artisan prefers words rather than symbols so that Artisan will continue to have difficulty in understanding the meaning of mathematical symbols.

Subject A characteristic as concrete communicator is also visible when subject A wrote what were known and what were asked on the three problems. Subject A wrote what were known and asked the question as it was appropriate given problem. It shows that the subject Artisan does not waste words are less important or replace words in a matter of becoming symbols or symbols that can summarize the sentence. This is appropriate to the Keirsey who classify Artisan as a concrete communicator.

Unlike the five other MCAs, subject A's ability to make conclusions in writing in their own words poorly. Subject A is less able to make conclusions in writing in their own words. Therefore, a teacher needs to provide the Artisan students habituation and providing guidance in making conclusions after the students solve the problems.

3.3 Discussion of Rational Student Mathematical Communication Ability Analysis

Results of the Rational mathematical communication ability analysis in accordance with the type Rational described by Keirsey (1998). Mathematical communication abilities of subject R have good because the subject R mastered 4 of 6 MCA, namely MCA 1,2, 4, and 6 very well. It is caused by Rational learners prefer natural sciences and mathematics (Keirsey, 1998) so that it becomes a

natural thing if the subject R have good mathematical communication ability. From Table 2, it can be seen that the subject of mathematical communication ability scores R represents the highest score compared to other subjects. Moreover, in general, the subject R also mastered MCA 5 well. Subject R able to write down the terms and mathematical symbols correctly and appropriately. But subject R made a little mistake in writing symbols on the answer sheet. The errors caused by carelessness of subject R. Therefore, a teacher needs to remind Rational students to be more careful in work on the problems.

Subject R only write the points contained in the problem in writing what are known and asked the three problems. It is caused by Rational student where as abstract communicator will not write the words that they think is not important (Keirsey, 1998). The characteristic as an abstract communicator is also seen on the subject R while writing answers appropriate with the problem intention and in writing the reasons in solving problems. Subject R always write the formula in solving the problems. Abstract communicator very fond of theories, formulas, and symbols (Keirsey, 1998). Aside from being a communicator abstract, subject R also show other characteristic as a Rational, that is utilitarian character. An utilitarian would use an effective way to solve the problem according to them. This is supported by the recognition of subject R that claimed using the formula as a shortcut to her problem solving. In contrast to about 1 and 2, subject R does not write the reasons in answer to question 3. It is caused by the time the test was too short and the subject R assumptions about the obvious answer that does not require the writing of reasons. That characteristic of subject R same as the characteristic of Rational that will limit their explanations because they assume that what is clear to them must have been clear to everyone else (Keirsey, 1998).

Moreover, in making sketch related to the problem, subject R also indicates the characteristic as abstract communicators and utilitarian. Results of the subject R test indicates that the subject is very frugal words. Subject R only wrote two symbols with a different pen as captions of his drawing. Subject R also simply write the symbol on the axis and on the axis to indicate that each unit on the axis and represents 1 hm. It can also be said to be more effective than having to write in words as practiced by other subjects.

In general, the ability of subject R in writing the terms and mathematics symbols is good because subject R is able to write down the terms and mathematics symbols in solving problems 1 and 3 correctly. Subject R solved problems in a way that had never previously given in teaching. This is appropriate to Keirsey & Bates in Yuwono (2010), which suggested that the Rational likes to seek information from other sources in learning.

3.4 Discussion of Idealist Student Mathematical Communication Ability Analysis

Results of the Idealist mathematical communication ability analysis in less accordance with the type Idealist described by Keirsey (1998). Subject I was able to write what were known and asked the three problems and was able to write down the answers appropriate with the problem intentions. But in writing down the answer, the subject I write less capable of reason in answering the questions. This is shown by the inability of the subject I wrote down the reasons in solving problems 1 and 3.

Interview results showed that subject I be able to express the reasons in solving problem 1, but subject I was not able to write the reason to the answer sheets. Subject I said that in determining the coordinates of the map of is to draw quadrilateral first, then subject I will determine the coordinates of the map by calculating the distance between objects with mirrors. It's hard if you have to write down that reason into words, but subject I can reveal it by picture. For example, subject I can make a segment from point to mirror then from mirror to the map of or , as well as to point and . But in fact subject I did not write anything as an excuse in solving problem 1. It shows that subject I was concrete communicators because subject I needs pictures (concrete objects) to determine the coordinates of the map and subject I is able to explain why only through words. This is contrary to the characteristic of the Idealist which should be an abstract communicator. It is also incompatible with her personality as an Idealist is when subject I makes sketch related to problem 3. At the test, subject I prefer to give testimony with words, not with symbols. It shows that subject I is a concrete communicator.

Basically, humans have four personality types Keirsey, but they have a tendency at least one personality. After the researcher examined further about the subject I's personality type in Table 1, subject I or in Table 1 coded as S21 has a tendency Idealist personality type. However, the second trend is the Artisan personality type. As which has been discussed previously that Artisan personality type is a concrete communicator, researcher suspect when subject I do the problems 1, she tends to Artisan type.

Subject I in writing the terms and mathematical symbols in solving problem can be said to have been good because subject I was able to write the terms and mathematical symbols in solving problems 1 and 3 correctly. But in solving problem 2, subject I made a mistake in writing the symbol . Result of interviews related to it indicates that subject I do not understand the meaning of the symbol . Symbols are intended by the subject is supposed to be arrows . Therefore, the Idealist students should be given advance an understanding of the meaning of mathematical symbols on a material.

Subject I 's ability to make conclusiona in writing using her own words is still lacking. Subject I write conclusions that are inconsistent with problems 1 and 2. Subject I write conclusions about the general problems of reflection and translation, not about the matter in problems 1 and 2. It shows that the subjects I do not understand the intent of the conclusion itself. Therefore, a teacher needs to provide insight and guidance the Idealist students how to write a good and correct conclusions.

4. CONCLUSION

Based on the results and discussion, concluded that: (1) Guardian subject master MCA 1, 2, 3, 4, and 5, but does not master MCA 6; (2) Artisan subject master MCA 1, 2, 3, and 4, but does not master MCA 5 and 6; (3) Rational subject master all MCAs, but has a tendency not to write down the reasons in problem solving; (4) Idealist subject master MCA 1, 2, and 4, but does not master MCA 3, 5, and 6.

Based on the results, discussion, and the conclusion, to improve students' mathematical communication ability in the mathematics learning, teacher should: (1) provide understanding to

Rational students to write reasons in solving problems so that the reader can understand the problem solving by Rational students easily; (2) familiarize and guide the Idealist students to write down reasons in solving problems; (3) provide understanding to Artisan, Rational, and Idealist students the meaning of terms and mathematical symbols of a material at the beginning of learning; and (4) familiarize Guardian and Idealist students to make conclusions in writing to use their own words.

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