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STUDENTS' MATHEMATICAL COMMUNICATION ABILITIES IN MATHEMATICAL PROBLEM SOLVING VIEWED FROM INTRAPERSONAL AND INTERPERSONAL INTELLIGENCES

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Abstract

Mathematical communication ability is needed by the students in mathematics learning because through communication, students can express their ideas/minds about mathematics as written or oral. Meanwhile, the differences of students' multiple intelligences, like intrapersonal and interpersonal intelligences, it made possible that there would be some differences between their writing and oral communication abilities in solving mathematics problems. The goal of this research are describing students' mathematical communication abilities with their intrapersonal and interpersonal intelligences level on writing and oral in solving mathematics problems. This research was descriptive research with qualitative approach. The instruments that used are questionnaire, mathematics test, and interview. The subjects of this research consist of four students, which are a student with high *intrapersonal* and *interpersonal* intelligences, a student with high *intrapersonal* and low *interpersonal* intelligences, a student with low *intrapersonal* and high *interpersonal* intelligences, and a student with low *intrapersonal* and *interpersonal* intelligences. Based on the description and analysis results about students' mathematical communication ability on writing and oral in solving mathematics problems viewed from the level of intrapersonal and interpersonal intelligences, then it can be concluded that the students with high intrapersonal intelligences in general have the written communication abilities better than the low one. While the students with high interpersonal intelligences in general have the oral communication abilities better than the low one.

Keywords*:* mathematical communication abilities, mathematical problem solving, intrapersonal and interpersonal intelligences

INTRODUCTION

Education is one of the important factors for human being from the past until now on. In this globalisation era, science and technology development needs human with high intelligences, one of them is the ability in mathematical aspect. Mathematics learning demand students have to become active, creative, and innovative, so the students can understand the material that have been learned as well as apply it in the daily life.

Due to that demand, *Partnership for 21st Century Skills* (in Setianingsih, 2016) claims that global citizen need four basic skills, which are: (1) critical and problem solving skills, (2) collaboration skills, (3) communication skills, dan (4) creativity and innovation skills. Nowdays, that four skills is called 4C. One of the 4C is communication skills.

Baroody (in Qohar, 2011) said that there are 2 important reasons why communication needs to be focus concern in mathematics learning, (1) Mathematics as language; mathematics not only the thinking helper tools, or finding pattern tools, or solving problem, but mathematics also an important tool to communicates kind of idea clearly, briefly, and accurately, (2) Mathematics learning as a social activity; mathematics learning is included the interaction between teacher and students, like communication each students, or communication between teacher and students.

Therefore, the communication abilities in mathematics, specially in mathematics learning, become a special demand. Like in NCTM (2000) that said communication is an essential part of mathematics and mathematics education. In this research, researchers divided the mathematics communication into two types which are written mathematics communication and oral mathematics communication.

In curriculum 2013, the government hopes that learning is not only teacher-centered but also student-centered. Learning needs to be prepared with a strategy that makes

students easy to construct their knowledges, so that students can communicate their minds to the teacher, students, or mathematics material itself. It is hoped that students can solve the problem, in this case solving mathematics problems. In the matter of importance of problem solving skills, NCTM (2000:182) said that problem solving is school mathematics base.

Based on the research results (Handayani, et al, 2014:51) and (Kaselin, et al 2013:122), it can be stated that the students' mathematical communication ability is still below standard. Higher or lower mathematical communication ability are affected by some factors, such as the differences of intelligences that students have. In this research, researchers want to observe at intrapersonal and interpersonal intelligences.

Safaria (2005) said that one of the characteristic of a person having high interpersonal intelligences is possessing communication skills that consists of effective listening skills and effective speaking skills. While a person that has high intrapersonal intelligences is having the written communication skills, passive in talk. Therefore, intrapersonal and interpersonal intelligences are influential to higher or lower students' written and oral mathematical communication abilities.

Based on the background above, the researchers want to conduct a research entitled "**Students' Mathematical Communication Abilities in Mathematical Problem Solving Viewed from Intrapersonal and Interpersonal Intelligences".**

The problems in this research are "How students' mathematical communication abilities with their intrapersonal and interpersonal intelligences level on writing and oral in solving mathematics problems". And the goal of this research are describing students' mathematical communication abilities with their intrapersonal and interpersonal intelligences level on writing and oral in solving mathematics problems.

METHODS

The research is descriptive research with qualitative approach. This research was conducted in one class of grade eight at MTsN 2 Surabaya in odd semester of the academic year 2017/2018. There are four students who become the research subjects. The research procedures are described in the following figure.

For the complete research procedures, from the beginning that is choosing material until getting the results, can be seen in Figure 1.

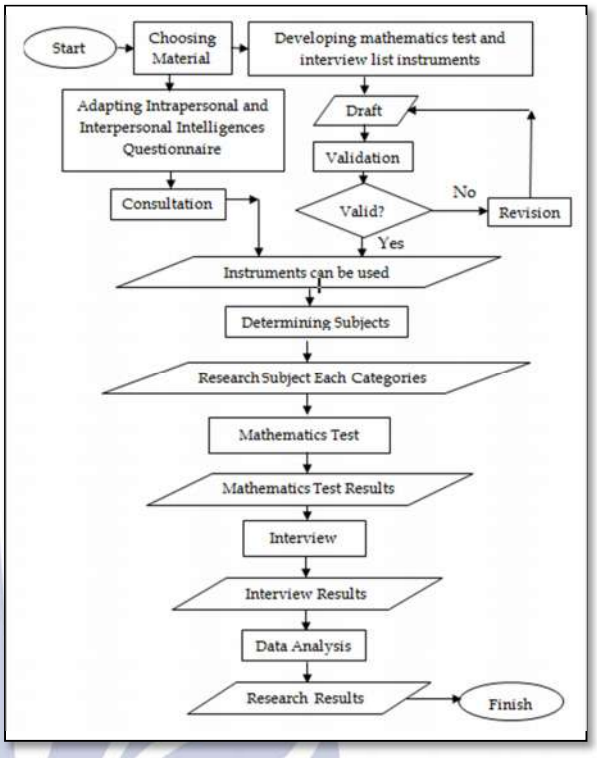

Figure 1. Research Procedures

The instruments that were used in this research consist of:

1. Intelligences questionnaire that was adapted from Barber (2005) with the title of *Positive Intrapersonal and Interpersonal Functioning* which had been checked its validity and reliability.
2. Mathematics test that was conducted by the researchers with type of essay. The test is validated by three validators who are mathematics lecturer, university students, and a mathematics teacher of MTsN 2 Surabaya.
3. Interview guide is conducted by the researchers and it also validated by three validators that are mathematics lecturer, bachelor university students, and teacher in MTsN 2 Surabaya.

The research was done three times. First, the researchers gave intelligences questionnaire to students in class VIII H to find out four research subjects. Second, the data were collected by using mathematics test to uncover the students' written communication abilities. Third, the interview process to uncover the students' oral communication abilities.

The analysis steps to find the research subject consist of scoring the intelligences questionnaire with intelligences syllabus and scoring orientation, then it was clasified with category of $x \geq 80$ for high intelligences, $70 \leq x < 80$ for medium intelligences, and $x < 70$ for low intelligences, with x is the students' score, then take four

research subjects from that category. They are one student with high *intrapersonal* and *interpersonal* intelligences, one student with high *intrapersonal* and low *interpersonal* intelligences, one student with low *intrapersonal* and high *interpersonal* intelligences, and one student with low *intrapersonal* and *interpersonal* intelligences.

The analysis steps for mathematics test and interview are used three indicators of communication that adapted from Dewi (2009) which consist of accurateness, completeness, and fluency. Besides using four solving problems steps from Polya (1973) which are understanding the problem, devising a plan, carrying out the plan, and looking back.

RESULTS AND DISCUSSIONS

This research was conducted in class VIII H at MTsN 2 Surabaya in odd semester of the academic year 2017/2018. On the first day, the researchers gave intelligences questionnaire to 34 students in class VIII H to find out research subjects. Based on the score, students grouped into some categories.

Table 1. Students' Intrapersonal and Interpersonal Intelligences

No	Name	*Intra* Score	Category	*Inter* Score	Category
1	AUN	72	Medium	83	High
2	AD	81	High	94	High
3	AKA	58	Low	63	Low
4	AFB	70	Medium	80	High
5	CI	79	Medium	89	High
6	DDR	74	Medium	71	Medium
7	EDRP	78	Medium	86	High
8	EFS	75	Medium	75	Medium
9	EZP	75	Medium	85	High
10	FSRS	80	High	89	High
11	IS	79	Medium	88	High
12	KHP	71	Medium	73	Medium
13	LNN	69	Low	74	Medium
14	MAS	70	Medium	75	Medium
15	MDP	66	Low	86	High
16	MAIF	81	High	87	High
17	MB	66	Low	82	High
18	MI	69	Low	63	Low
19	MYA	69	Low	70	Medium
20	MLF	83	High	86	High
21	MRC	68	Low	68	Low
22	NC	70	Medium	74	Medium
23	NMR	73	Medium	75	Medium
24	MAL	69	Low	73	Medium
25	RSL	80	High	68	Low
26	RR	73	Medium	73	Medium
27	SANI	71	Medium	64	Low
28	SA	78	Medium	79	Medium
29	SAS	74	Medium	87	High
30	SWD	73	Medium	73	Medium
31	SR	77	Medium	75	Medium
32	SDNF	85	High	83	High
33	WU	72	Medium	72	Medium
34	ZTN	67	Low	73	Medium

From Table 1, it shows that there are 5 students on the first category, 1 student on the second category, 2 students on the third category, and 3 students on the fourth category. Based on the score and teacher recommendation, four research subjects that researchers choose as in the following table.

Table 2. List of Research Subjects

No	Name	Code	Intra Score	Inter Score	Intelligences Categories
1	MLF	STT	83	86	High - High
2	RSL	STR	80	68	High - Low
3	MDP	SRT	66	86	Low - High
4	AKA	SRR	58	63	Low - Low

Notes:

STT = students with high intrapersonal and high interpersonal intelligences

STR = students with high intrapersonal and low interpersonal intelligences

SRT = students with low intrapersonal and high interpersonal intelligences

SRR = students with low intrapersonal and low interpersonal intelligences

The answers of mathematics test and interviews' result are encoded by researchers to organize the data easier. The code of mathematics test is presented in Table 3.

Table 3. The Code of Mathematics Test Result

Code	Explanation
Sij – x T	Written information from the subject with i intrapersonal level and j interpersonal level sequence-x

Then, the code of interviews' result is presented in Table 4.

Table 4. The Code of Interviews' Result

Code	Explanation
P - x	Question x from researchers
Sij – x	Oral answer from the subject with i intrapersonal level and j interpersonal level sequence-x

1. Data Analysis and Discussion about Mathematics Test to Find Students' Written Mathematics Communication Ability

   a. Data Analysis and Discussion of STT

   The answer from STT is presented in Figure 2 and the analysis of its data is presented below the figure.

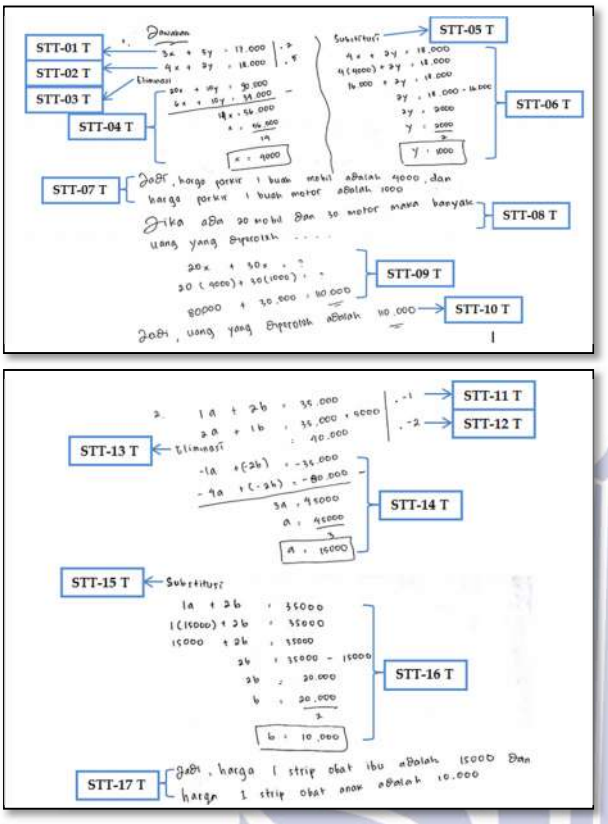

Figure 2. The Answer of Mathematics Test By STT

In the answer sheet, STT do not write the understanding problems steps. STT writes the devising a plan steps accurately and completely (STT-03 T, STT-05 T, STT-13 T, STT-15 T). STT writes the carrying out the plan steps accurately and completely (STT-01 T, STT-02 T, STT-04 T, STT-06 T, STT-11 T, STT-12 T, STT-14 T, STT-16 T). STT writes the looking back steps accurately and completely (STT-10 T and STT-17 T). Then, STT doing the mathematics test on time, that's mean STT doing problem solving steps fluently. The analysis results can be seen in Table 5.

Table 5. The Result of STT Analysis about Mathematics Test

No	Solving Problem Steps	Written Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Inaccurately	Incompletely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	
2	Understand-ing the Problem	Inaccurately	Incompletely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	

From the table above, it can be stated that STT is good in written communication ability.

b. Data Analysis and Discussion of STR

With the same steps and the same analysis like STT analysis before, researchers get the analysis results of STR that can be seen in Table 6.

Table 6. The Result of STR Analysis about Mathematics Test

No	Solving Problem Steps	Written Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Inaccurately	Incompletely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	
2	Understand-ing the Problem	Inaccurately	Incompletely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	

From the table above, it can be stated that STR is good in written communication ability.

c. Data Analysis and Discussion of SRT

With the same steps and the same analysis like STT analysis before, researchers get the analysis results of SRT that can be seen in Table 7.

Table 7. The Result of SRT Analysis about Mathematics Test

No	Solving Problem Steps	Written Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Inaccurately	Incompletely	Fluently
	Devising a Plan	Inaccurately	Incompletely	

	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Inaccurately	Incompletely	
2	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Inaccurately	Incompletely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	

From the table above, it can be stated that SRT is quite good in written communication ability.

d. Data Analysis and Discussion of SRR

With the same steps and the same analysis like STT analysis before, researchers get the analysis results of SRR that can be seen in Table 8.

Table 8. The Result of SRR Analysis about Mathematics Test

No	Solving Problem Steps	Written Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Inaccurately	Incompletely	Not Fluent
	Devising a Plan	Inaccurately	Incompletely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Inaccurately	Incompletely	
2	Understand-ing the Problem	Inaccurately	Incompletely	Not Fluent
	Devising a Plan	Inaccurately	Incompletely	
	Carrying Out the Plan	Inaccurately	Incompletely	
	Looking Back	Inaccurately	Incompletely	

From the table above, it can be stated that SRR is not good in written communication ability.

2. Data Analysis and Discussion about Interview Results to Find Students' Oral Mathematics Communication Ability

a. Data Analysis and Discussion of STT

The answer from STT is presented in Figure 3 and the analysis of its data is presented below the figure.

P-02 : Untuk soal yang pertama, apa yang diketahui dari soal yang diberikan?
STT-02 : Yang diketahui harga 3 buah mobil parkirnya tidak diketahui, dan 5 buah motor tidak diketahui, setelah itu disuruh mencari harga parkir 1 mobil berapa dan harga parkir 1 motor berapa yang hasil akhirnya 17.000
Harga 4 buah mobil dan 2 buah motor itu berapa hasilnya kok 18.000
P-03 : Sekarang apa yang ditanyakan dari soal yang diberikan?
STT-03 : Harga parkir 20 mobil dan 30 motor dan berapa banyak uang yang diperoleh
P-04 : Langkah atau rumus apa yang digunakan untuk menyelesaikan masalah tersebut?
STT-04 : Caranya yaitu menghilangkan satu abjad dengan cara eliminasi, kemudian setelah menemukan nilai satu abjad tersebut lalu disubstitusikan
P-05 : Mengapa Anda memilih langkah tersebut?
STT-05 : Karena lebih mudah untuk dipahami
P-06 : Jelaskan secara lengkap langkah-langkah yang digunakan untuk mencari jawaban tersebut!
STT-06 : $3x + 5y = 17.000$
Atau 3 mobil ditambah 5 motor sama dengan 17.000
Lalu 4 mobil dan 2 motor sama dengan 18.000
Agar kita lebih mudah mencari abjadnya harus dikali salah satu atau dibagi
Setelah dikalikan didapat,
$20x + 10y = 90.000$
$6x + 10y = 34.000$
Kemudian dikurangkan, dihilangkan y-nya
$20x - 6x$
$= 90.000 - 34.000$
$14x = 56.000$
$x = \frac{56.000}{14} = 4.000$
Karena sudah memperoleh harga parkir 1 mobil yaitu 4.000 kemudian disubstitusikan
$4x + 2y = 18.000$
$4(4.000) + 2y$
$= 18.000$
$16.000 + 2y = 18.000$
$2y = 18.000 - 16.000$
$y = \frac{2.000}{2} = 1.000$
P-07 : Jelaskan kesimpulan yang Anda peroleh dari jawaban yang sudah didapatkan!
STT-07 : Kesimpulannya bahwa harga parkir 20 mobil dan 30 motor yaitu 110.000
P-08 : Apakah kesimpulan sudah menjawab pertanyaan?
STT-08 : Sudah

Figure 3. The Answer of Interview Process By STT

In the interview records, STT stated the understanding problems steps accurately and completely (P-02 until STT-03). STT tells the devising a plan steps accurately and completely (P-04 until STT-05). STT tells the carrying out the plan steps accurately and completely (P-06 and STT-06). STT tells the looking back steps accurately and completely (P-07 until STT-08). Then, STT doing the interview process clearly and on time, that's mean STT doing problem solving steps fluently. The analysis results can be seen in Table 9.

Table 9. The Result of STT Analysis about Interview Results

No	Solving Problem Steps	Oral Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	
2	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	

From the table above, it can be stated that STT is good in oral communication ability.

b. Data Analysis and Discussion of STR

With the same steps and the same analysis like STT analysis before, researchers get the analysis results of STR that can be seen in Table 10.

Table 10. The Result of STR Analysis about Interview Results

No	Solving Problem Steps	Oral Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	
2	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	

From the table above, it can be stated that STR is good in oral communication ability.

c. Data Analysis and Discussion of SRT

With the same steps and the same analysis like STT analysis before, researchers get the analysis results of SRT that can be seen in Table 11.

Table 11. The Result of SRT Analysis about Interview Results

No	Solving Problem Steps	Oral Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	
2	Understand-ing the Problem	Accurately	Completely	Fluently
	Devising a Plan	Accurately	Completely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	

From the table above, it can be stated that SRT is good in oral communication ability.

d. Data Analysis and Discussion of SRR

With the same steps and the same analysis like STT analysis before, researchers get the analysis results of SRR that can be seen in Table 12.

Table 12. The Result of SRR Analysis about Interview Results

No	Solving Problem Steps	Oral Communication Aspects		
		Accurateness	Completeness	Fluency
1	Understand-ing the Problem	Accurately	Completely	Not Fluent
	Devising a Plan	Inaccurately	Inompletely	
	Carrying Out the Plan	Accurately	Completely	
	Looking Back	Accurately	Completely	
2	Understand-ing the Problem	Accurately	Incompletely	Not Fluent
	Devising a Plan	Inaccurately	Incompletely	
	Carrying Out the Plan	Inaccurately	Incompletely	
	Looking Back	Inaccurately	Completely	

From the table above, it can be stated that SRR is not good in oral communication ability.

3. Discussions
   a. Students with high intrapersonal and high interpersonal intelligences have good mathematics communication ability in solving mathematics problems.
   b. The researchers do not use the students' mathematical abilities as a control variable. The researchers just determine the research subjects by their intrapersonal and interpersonal intelligences.
   c. Students with low intrapersonal and low interpersonal intelligences are difficult to communicate their own information, not as easy as when students with high intrapersonal and high interpersonal intelligences communicate their information, so they need a special treatment from the teacher and school to increase their intelligences, specially on intrapersonal and interpersonal intelligences.

CLOSURE

Conclusions

Based on the description and analysis results, it can be concluded that students with high intrapersonal intelligences in general have better written communication abilities than the low one. In addition, students with high interpersonal intelligences in general have better oral communication abilities than the low one.

Suggestions

1. For the next research, it is need to add another control variable that is students' mathematical abilities. In a case that the research subjects have the similar mathematical ability level, it may affect the research results because of the differences of students' intrapersonal and interpersonal intelligences, not because of the differences of mathematical abilities.
2. Students with lower intrapersonal and lower interpersonal intelligences, are difficult to communicate their own information, so they need a special treatment from the teacher and school to increase their intelligences. To increase their intrapersonal intelligences, it is better to do the scheduled counseling and listening about the difficulties that students feel. Whereas, to increase their interpersonal intelligences, gives them the learning activity that needs teamwork and discussion activity so the students can be more chummy each others.
3. The research still limited in students' mathematical communication abilities in mathematical problem solving with linear equation systems in two variables viewed from intrapersonal and interpersonal intelligences. For the next research, it is better to change to other material with other level like in senior high school, or change the intrapersonal and interpersonal intelligences to other multiple intelligences so there are more variations on the results that will be get.

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