Mathematics communications skill of student in senior high school on introvert

A C Septiana*, T A Kusmayadi1 and L Fitriana1

1Departemen of Mathematics Education, Faculty of Teacher Training and Education Universitas Sebelas Maret, Indonesia.

E-mail: anggrahinyclara14@gmail.com

Abstract. Introvert personality is a characteristic of students stimulates thought and behavior. For this reason, introvert personality can influence mathematics learning and students’ mathematics communication. Through mathematics communication, students can organize the ability to think both verbally and in writing. This study aimed to analyze the mathematical communication skills of students who had an introvert personality. The research method used was descriptive qualitative with 20 subjects in the eleventh grade of a national senior high school in Sukoharjo. The data was collected through questionnaires, tests, and interviews. The results of this study are the students who had an introvert personality type who was able to analyze and write information obtained by mathematical symbols was 90 % in the high category. The indicator of mathematics communication capabilities that are expressing ideas, mathematical situations or with pictures, graphs, and algebraic forms, which have a percentage of 24.5% in the low category.

1. Introduction
Good quality education will produce good academic achievement. One effort to achieve the quality of education is through mathematics or mathematics. One of the goals of learning mathematics so that students are able to communicate ideas or ideas they have to solve problems. Communication plays a role in the learning process because through communication a student can convey ideas or ideas, understanding and opinions to teachers, peers, groups, or the whole class. One aspect that can affect mathematics learning is communication skills. Communication and collaboration are often cited as 21-century skills. Communication is the process of sending information, ideas, emotions, abilities, and others through the use of symbols such as words, pictures, numbers, and so on. Whereas the mathematical definition of communication ability is the ability of a person to write mathematical statements, to write reasons or explanations of any mathematical arguments he uses to solve mathematical problems, to use terms, tables, diagrams, notations, or mathematical formulas correctly, and to check or evaluate another mathematical mind [1].
Similarly, the presence of communication in a classroom environment has been considered an essential element of quality education for many years. Research shows, however, that this purposeful interaction in mathematics classrooms, although significant, is often overlooked and replaced by approaches that are only focusing on mathematical procedures, the empty context, communication, and the true essence of the mathematical concepts needed to promote mathematical literacy [2,3]. Communication in written and verbal forms is important in mathematics because it is needed to improve overall mathematical understanding [4,5].

The purpose of mathematics learning according to NCTM is that there are five main standards of mathematics learning including problem-solving, reasoning and verification, communication, connection, and representation. In accordance with the General State Core Standards Initiative [6] also recognizes that communication in mathematics learning is important because it is included as an important practice standard. Both of these documents outline standards for teaching and learning mathematics and recognize that mathematics communication allows students to explore concepts from a variety of perspectives and understand their thinking more clearly [2,7]. Similarly, the International Baccalaureate Curriculum explains the intended purpose of mathematics learning so that students become competent users of the language of mathematics and start using it as a way of thinking, or communicate mathematically as opposed to seeing mathematics as a series of facts and similarities that must be remembered [8]. Although this perspective is widely accepted for the inclusion of communication as an important part of mathematics learning, many teachers ignore the opportunity to include communication in mathematics [9].

Several studies have found that the low mathematical communication skills seen in the report, which states that the ability of Indonesian students in mathematical communication is still very far below other countries. For example, for mathematical problems involving mathematical communication skills, Indonesian students who succeed are only 5% and far below other countries such as Singapore, Korea, and Taiwan which reach more than 50% [10]. In accordance with other studies stating that 58.54% of students still have difficulty in working on worksheets related to expressing in mathematical sentences and lack of courage in asking questions and responding to problems [11].

Students experience obstacles in communication skills that are influenced by internal factors, one of which is personality. Intelligence and personality are important factors to be studied related to academic achievement according to [12]. People have different characteristics that affect their lives, these personal characteristics influence even the way they learn. The term "personality" includes a collection of different attributes that make up a significant individual. Personality is defined as an individual feature that takes into account emotional patterns that remain, behave, and think. Personality traits have been conceptualized from various theoretical forms. Apart from opposing conceptualizations of structure, these theories have contributed to our understanding of personality traits as personal difference variables to study experience and also codes of behavior [13]. These different characteristics are called a person's personality type [14]. Personality character is a type of personal characteristic that can affect the performance and learning of motor skills.

Jung distinguishes personality types into two types, namely Extraversion and Introversion, both of which refer to the extent to which a person's orientation is directed outside (the outside world) or into the individual [15]. According to Tinger & Barron-Tinger that Introverted personality is the nature of people who are imaginative, self-centered and idealism, characterized by many think before acting or speaking, more easily stimulated by new ideas and situations unusual, meticulous, earnest, and consistent. Whereas extroverted personality is the nature of people who are imaginative people, centered on the outside world and idealism, often characterized as acting without much thinking, tend to show their emotional state openly, tend to prefer to act directly than dreaming, and tend to be inconsistent [16].
Differences in Introverts and Extroverts are people who have introverted personalities who rarely socialize and prefer to seek self-identity or solitude, while extroverts tend to welcome anyone with a smile on their faces and more socializing. Usually, extroverts have more friends than introverts, because introverts do not like crowds; therefore, they have few friends [17]. People who have extrovert personality use simple ways to see the extent to which an individual engages the ego, a sense of wholeness of others as opposed to achieving self-assertiveness and self-esteem. Conversely, introverts may be shy and need affirmations from others [18]. An extrovert type often uses movement and writing in communication compared to introverted types [19].

There is a significant relationship between personality types with learning motivation, and ability to solve problems faced by students [20]. And remembering the importance of communication in learning mathematics and the low ability of mathematics in Indonesia, for that reason the analysis of students' mathematical communication skills is very important so that in the future educators can determine the right methods and models to overcome various problems experienced and will ultimately have an impact learning outcomes [21].

Because of the importance of mathematics communication in learning and the existence of relationships with personality and communication, researchers were interested in examining students' mathematics communication skills from the perspective of the introverted personality. Like other researchers who examined the influence of mathematics communication on mathematics learning achievement [22]. Examine the teacher teaching technique viewed from the perspective of the personality possessed by a teacher [23]. In this study focused on introverted personality. Also examined the impact of cooperative learning on students who have introverted personalities [24]. While this study only analyzes the communication skills of students who possess an introverted personality. Some even examine communication through social networks by looking at the perspectives of introverted and extroverted personalities [25], but this study focused on mathematics communication. In this study, students will discuss mathematical communication skills concerning introverted personality.

2. Method
This study used descriptive qualitative methods. The purpose of this research was to analyze the mathematical communication skills of students who had an introverted personality. Students were selected with purposive sampling. The subjects of this study were 20 students in eleventh grade of a national senior high school in Sukoharjo. The school of the research subjects was selected based on the absorption of the 2016/2018 high school UN Sukoharjo grades in linear program material.

Data collection techniques in this study used the instrument of written test, questionnaire, and interview. Mathematical communication data were collected through essay tests. The topic of the essay test was a linear program. The interview conducted aimed to explore information from the subject regarding the reasons for answering communication problems that had been done before.

The triangulation used technique triangulation. Triangulation was used to confirm the validity of the data by comparing the results of written mathematical communication tests and the results of the interviews. Data analysis techniques in this study included: (1) reducing the data, (2) the presentation of the data, and (3) conclusion.

3. Result and Discussion
In this study, indicators of mathematical communication skills synthesized by Hendriana and Soemarmo and Yang, Chang, Cheng, and Chan. These indicators are analyzing and writing information obtained into mathematical symbols; reading by understanding mathematical equations; expressing ideas, mathematical situations oral or with pictures, graphics, and algebraic forms; Arranging conjecture, arguments
or formulate definitions of generalizations; and revealing mathematical sentences into his language. The result of this research shows the score and percentage of students’ mathematics communication indicators as in Table 1.

Table 1. Mathematics Communication Skill of Introvert Personality

| No | Mathematics Communication Skill Indicators                                                                 | Personality Introvert | Score | %    | Categories |
|----|------------------------------------------------------------------------------------------------------------|-----------------------|-------|------|------------|
| 1  | Analysing and writing information obtained into mathematical symbols.                                        |                        | 360   | 90%  | High       |
| 2  | Reading with understanding a mathematical equation.                                                          |                        | 120   | 30%  | Low        |
| 3  | Expressing idea, mathematical situation oral or with picture, graph and algebra form.                       |                        | 98    | 24.5%| Low        |
| 4  | Arranging conjecture, argument or formulating generalization definition.                                    |                        | 275   | 68.75%| Medium    |
| 5  | Revealing a mathematical sentence into its own language                                                   |                        | 340   | 85%  | High       |

Based on Table 1, students having introvert-extrovert personality can classify into high, medium and low categories based on the percentage obtained. It is includes high category if the percentage is between 70.01%-100%, while medium category between 30.01%-70% and low category between 0%-30%. Mathematical communication skills of students who have an introvert personality there are five indicators, the first indicator is that students are able to analyze and write information obtained with mathematical symbols, which are in accordance with the results of table I which shows a percentage of 90% in the high category. The second indicator of mathematical communication skills is reading by understanding mathematical equations, which have a percentage of 30% which is included in the low category. The third indicator of mathematical communication skills in expressing ideas, mathematical situations or with images, graphics and algebraic forms, which have a percentage of 24.5% which is included in the low category. The fourth indicator of mathematical communication skills is to compile estimates, arguments or formulate a definition of generalization, which has a percentage of 68.75% which is included in the medium category. The fifth communication indicator is formulating it in its language, which corresponds to the results of the table which shows a percentage of 85% in the high category.

The following description is the research result consisting of public description about students’ mathematics communication skill which has introvert personality. In this study using two problems. The first problem is the system of two-variable linear equations with the theme of nutrition, as follows. To treat patients, a hospital requires at least 225,000 units of calories and 195,000 units of protein per day. Every 1 kg of beef contains 750 units of calories and 300 units of protein, while every 1 kg of fresh fish contains 450 units of calories and 600 units of protein. The price per kg of beef and fresh fish in sequence is Rp. 90,000 and Rp. 60,000. Determine the amount of beef and fresh fish (kg) that the hospital must provide so that the costs incurred are the smallest?

From the first problem, there are two images that represent the results of student answers that can be analyzed as follows:
Figure 1 shows that students only write information obtained in the question, but are unable to analyze and write it into symbols or do not symbolize it. Based on the results of the interview, it turns out that the student understands and knows about algebra, but he forgets not to suppose or symbolize it. When the second indicator in mathematics communication he has not been able to read by understanding a mathematical equation. He pointed out incorrectly in writing a mathematical equation. Based on the results of the interview, the student lacked understanding in SPLD. He only knew how to write equations to find a point to make a line. Searching for the x and y values to make the line shows that it is capable of expressing ideas, mathematical situations in writing in algebraic form, but has not been able to express them graphically. From the results of the interview, the student revealed that he was still alive and unaware when drawing a graph to find the intersection of a line. They should also wait for their ideas in graphical form, so there is no doubt the truth of the answers they get. The student also has not been able to arrange the steps to do it or the conjecture, form an argument and formulate the generalization definition correctly which shows that there is no critical point and his error in the mathematical calculation which causes an error in finding the intersection or x and y values. In Figure 1 it also shows that students have not been able to express a mathematical sentence back into their language. It shows that students’ work does not write the final results or conclusions of their work to answer the problem. Based on the results of the interview, the student said that he was better off working until it was done instead of continuing later because he did not know the next step.

Figure 2 is the result of student work with the same problem as in Figure 1. It indicates that the student is able to analyze and write the information obtained into the symbol. In accordance with the results of the interview, the student is able to explain the symbol he wrote. Symbol x is used to symbolize beef and y is used to fish meat. However, he has not been able to express ideas, graphical, mathematical situations which are shown wrongly in determining the settlement area. Based on the results of the interview, the student said that he was confused in reading the punctuation inequality in determining the nurturing, he was only from making a graph and purifying it. The student has been able to re-express a mathematical sentence into his language, even though the result is wrong.
The second problem relates to a linear program with the theme of production. The following is the second problem for analyzing students' mathematics communication skills.

A company produces gongs with three sizes, namely large, medium and small. The three gong sizes are produced using machines I and II. Every day the I machine produces 1 ton of large size goods, 3 tons of medium size goods and 5 tons of small size. Machine II produces 2 tons for each item size. The company intends to produce goods of at least 80 tons of large size, 160 tons of medium size and 200 tons of small size. The operational cost of machine I is 1,200,000 per day and machine II with an operational cost of 900,000 per day. Determine the length (days) of work of each machine to obtain the minimum operating costs possible?

From the first problem there are two images that represent the results of student answers that can be analyzed as follows.

Figure 3 and Figure 4 are the work of students with different questions from Figure 1 and Figure 2. Figure 3 shows that students have been able to analyze and write information obtained into the mathematical symbol shown by being able to make examples with x and y symbols and make table information. However, these students have not been able to read by understanding a mathematical equation. Shown incorrectly in giving inequalities in mathematical equations. Strengthened by the results of interviews with students, who said that they did not understand regarding inequality in the linear equation and he was still confused in distinguishing his mark. However, these students have been able to express ideas, mathematical situations into writing in the form of algebra and mathematical equations, and are able to determine the point for making lines. But these students have not been able to express ideas, mathematical situations graphically shown in the work of students in the absence of graphic images. The results of the interview, the student said that he still had difficulties in drawing graphic, and determined the areas of completion later in the graph. However, the student is able to compile a conjecture, form an argument or formulate a generalist definition which is indicated by the value of x and y (intersection) and incorrectly in determining the critical point for f minimum, even though it is wrong to determine the critical point. The language itself, even though the result is wrong.

Figure 4 shows that students analyze and write information obtained into mathematical symbols and are able to read by understanding a mathematical equation. These students are also able to embody ideas, graphical situations and writing algebraic forms. However, the student is wrong in determining the settlement area which results in incorrectly determining the intersection point and because it does not use elimination in determining the x and y values. Based on the results of the interview, the student said that he was confused in reading the inequality in order to purify and determine the settlement area, so he was only from the inside of the graph. Based on the results of the interview and the results of the
student's work, it was also seen that it was unable to construct the conjecture, form arguments or formulate generalist definitions which indicated the absence of x and y values (intersection points) and incorrect in determining critical points for f minimum. The student has been able to re-express a mathematical sentence into his language, even though the result is wrong.

From some analysis of student answers above, the researcher concludes that mathematics communication of students who have an introverted personality is able to analyze and write information obtained into mathematical symbols, able to formulate generalist definitions and able to express mathematical sentence into its language. Based on the data analysis of researchers about the difficulties of students in solving the problem of linear equations, it can be concluded that students have difficulty determining between point and line, factual, conceptual, operational, and principle difficulties in solving the problem of linear equations. Factual difficulties related to determining Cartesian coordinate points. Conceptual difficulties related to the concept of line intersection, the concept of x and y intersections. Operational difficulties related to work and algebraic calculations. Principal difficulties related to determining formulas or methods to determine intersection line points [26]. The student showed that he imaginative people were either alone or closed, often or characterized by thinkers, more easily stimulated by new, thorough, earnest, and consistent ideas following research that states that students who have introverted personalities usually tend to be careful listeners, detailed observers, and reflective [27]. Other researchers also found that introverts tend to predict a higher level of negative (more thinking) influence, which inhibits their ability to emerge as leaders because they are afraid to step up and make decisions [28].

These students have not been able to read with an understanding of mathematics, express ideas, mathematical situations correctly and arrange conjectures, arguments. In accordance with the results of research which states that students who have introvert personality tend to have difficulty in reading with an understanding of mathematical equations [29]. Moreover, there are differences in the intensity of communication through social networks between extroverted personality types and introverted personality types, introverted personality types are more self-closing or rarely socialize [25].

4. Conclusion
Based on the results of the analysis of this research data, it can be concluded that the mathematical communication skills of students who have an introvert personality there are five indicators. The indicator is, analyzing and writing information obtained into mathematical symbols, reading by understanding a mathematical equation, expressing ideas, graphical, mathematical situations or writing algebraic forms, arranging conjectures, composing arguments or formulating definitions of generalization, re-expressing a mathematical sentence into language itself is 90% (high); 30% (low); 24.5% (low); 68.75% (medium) and 85% (high).

Mathematical communication skills of students who have introvert personality on the ability to analyze and write information obtained into mathematical symbols including high categories. This student easily understands what must be said or changed into mathematical symbols. Students' mathematical communication skills in the ability to express ideas, graphical, mathematical situations or algebraic forms of writing include low categories. Students have not been able to change math equivalents into a graphic image. Many students have difficulty determining the area of completion. Students also have not been able to read comprehension of a mathematical equation that results in students having difficulty drawing grafik. Using this graph aims to determine and check the intersection to answer the existing problems. For this reason, students should be given math problems so that the mathematics communication in each student is stimulated and becomes better. The teacher must also pay attention and use mathematics communication in learning and pay attention to one's personality type so as not to be wrong in providing solutions.

Acknowledgement
The authors would like to thank the references for improving the quality of this paper and also from senior high school in Sukoharjo region with heterogeneous abilities for the opportunity to do research.
References
[1] Sari D S, Kusnandi K and Suhendra S 2017 A cognitive analysis of communication ability on geometry Journal of Physics Conf. Series 895 012083
[2] NCTM 2000 Principles and Standards for School Mathematics (Reston, Virginia : NCTM).
[3] NCTM 2009 Focus in high school mathematics: Reasoning and sensemaking (Reston, Virginia : NCTM)
[4] Turner R 2011 Identifying cognitive processes important to mathematics learning but often overlooked Australian Mathematics Teacher 67 pp 22-26.
[5] Wood K, Jones J, Stover K and Polly D 2011 STEM literacies: Integrating reading, writing, and technology in science and mathematics Middle School Journal 43 pp 55-62
[6] Council of Chief State School Officers (CCSSO) 2010 The common core state standards
[7] Adams A 2010 Rehearsal or reorganization: Two patterns of literacy strategy use in secondary mathematics The Montana Mathematics Enthusiast 7 pp 371-390.
[8] International Baccalaureate Organization 2015 Mathematics guide (Cardiff, Wales: International Baccalaureate Organization).
[9] Turner R 2011 Identifying cognitive processes important to mathematics learning but often overlooked Australian Mathematics Teacher 67 pp 22-26.
[10] Fachrurozi 2011 J. Penelitian 1 pp 76-89
[11] Ranti M 2015 J. Pendidikan Matematika 1 pp 96-102
[12] Ciorbea I and Pasarica F 2012 the study of the relationship between personality and academic performance J. Elsevier Procedia-Social and Behavioral Sciences 3 pp 52-67
[13] Pourfeiz J 2015 Exploring the relationship between global personality traits and attitudes toward foreign language belajar. Procedia - Social and Behavioral Sciences 186 pp 467–473
[14] Boroujeni, Roohani and Hasanimanesh 2015 the impact of extroversion and introversion personality types on efl learners’ writing ability J. Theory and Practice in Language Studies 5 pp 212-29
[15] Suryabrata S 2002 Psikologi kepribadian (Jakarta: PT Rajawali Pers)
[16] Prakash S, Singh A and Yadav S K 2016 personality (introvert, and extrovert) and professional commitment effect among bed teacher educator students J. Indian psychology 3 pp 43-9
[17] Mega S 2017 Effect of roundtable Teaching Techniques and clustering and the personal nature of students on student achievement in writing J. Australian International Academic 8 pp 69-75
[18] Azadi A, Gholami R, Periannan R, Sermanshahi E and Vaseghi R 2015 Difference between the performance of extrovert and introvert EFL learners on task-based information-gap, opinion-gap and reasoning-gap activities. Global English-Oriented Research Journal 1 pp 166–182
[19] O’Carroll S 2015 The effect of extroversion on communication: evidence from an interlocutor visibility manipulation J. Elsevier Speech Communication 69 pp 1-8
[20] Sari H and Shabari 2016 Idea nursing journal 7 pp 1-10
[21] Rohman A A 2017 J. Ilmiah Pendidikan Matematika 5 pp 7-20
[22] Lomibao L S, Luna C A and Namoco R A 2016 J. of education research 4 pp 378-82
[23] Shabani K and Ghasemian A J 2017 Tipen dan teknik kepribadian guru mengajar pengucapan. Cogent Education 4 pp 1-16
[24] Jacobs G M 2017 Introverts and cooperative learning IASCE Newsletter 36 pp 7-8
[25] Widiantari K S and Herdiyanto Y K 2013 J. Psikologi Udayana 1 pp 106-15
[26] Wati S, Fitriana L and Mardyana 2018 Students’ difficulties in solving linear equation problems International Conference on Mathematics, Science and Education (ICMSE) Journal of Physics: Conference Series 983 012137
[27] Spark A, Stansmore T and O’Connor P 2018 Introverted failure to emerge as a leader: Roles that are thought to affect J. Science Direct 121 pp 84-88
[28] Widiantari K S and Herdiyanto Y K 2013 J. Psikologi Udayana 1 pp 06-15
[29] Septiana A C 2018 Mathematical communication skill of senior high school students based on their personality types Journal of Physics:Conference Series 1108 012027