Mathematical communication and social skills of the students through learning assurance relevance interest assessment and satisfaction

N Ratnaningsih*, R Hermanto, and N S Kurniati
Departement of Mathematics Educations, Siliwangi University, Tasikmalaya City, Indonesia

*naniratnaningsih@unsil.ac.id

Abstract. The purpose of this research is to analyze mathematical communication skills and find patterns in thinking process of students in terms of social skills through learning Assurance Relevance Interest Assessment and Satisfaction (ARIAS). This research was conducted in Tasikmalaya city with 80 students as research subjects. The research method uses a sequential explanatory combination. Data was collected through tests of mathematical communication skills and social skills questionnaires. Data analysis techniques to test hypotheses using proportion tests. Based on the results of data analysis, it was concluded that mathematical communication skills of the students through ARIAS learning achieved ideal completeness.

1. Introduction
Mathematics is a science that can be applied in various fields of science, therefore mathematics is important to be given and studied by students at various levels of school. According to Cornelius in Aula et al. there are five reasons for the importance of learning mathematics [1]: it is a means for thinking clearly and logically, solving problems in daily life, knowing the relationship between patterns and generalizations, developing creativity and increasing awareness of cultural development. In connection with that, various cognitive, affective, and skills abilities need to be trained by students at various levels of the school, from primary, secondary and tertiary education. The 2013 curriculum in Indonesia requires students to be trained in three domains, namely cognitive, affective, and skills. As stated by the National Council of Teachers of Mathematics [2,3], the aim of students is to study mathematics, namely to develop: mathematical problem solving, mathematical communication, mathematical reasoning and proof, mathematical connection and mathematical representation.

This study focused on two domains, namely cognitive and affective, the cognitive domain takes communication skills and the affective domain takes social skills. In line with the statement from National Council of Teachers of Mathematics communication skills are essential in learning...
mathematics [2]. In addition, according to Hirschfeld-Cotton communication skills help build meaning, when students must give reasons and express ideas [4]. Opinion Yusra and Saragih that mathematical communication skills are necessary to express mathematical ideas with symbols, tables, diagrams or other media to clarify mathematical understanding [5]. Even according to Kist Further states that mathematical communication skills are not only given to mathematics subjects but must be given to other subjects [6,7]. According to Elliott and Kenney various mathematical communication skills can be trained to students [8], namely written text is to provide answers by using their own language, modeling a situation or problem using oral, written, concrete, graph and algebra, explaining and making statements about mathematics that has been studied, listened to, discussed, and wrote about mathematics, compiled conjectures, compiled arguments and generalizations. Drawing is reflecting real objects, images, and diagrams into mathematical ideas. Mathematical expressions are expressing mathematical concepts by expressing daily events in mathematical language or symbols. In addition, the opinion of Baroody and Coslick [9], and Alhaddad et al. [10] communication skills include 5 aspects: representing, listening, reading, discussing and writing.

Based on the results of the observations done by the researchers by giving a test of mathematical communication skills in students of class XII MIPA 3 in the material derived from algebraic functions, there are 3 items that refer to indicators of mathematical communication skills namely written text, drawings and mathematical expressions. From the analysis results of the answers of the students to the written text problem, from 35 students there were 22 students that made mistakes in the formulation of ideas, situations and mathematical relations, 8 students were able to formulate ideas, situations and mathematical relations but did not reach the stage 2 students were able to formulate ideas, situations and mathematical relations but were not systematic. This shows that mathematical communication skills in the written text indicator have not been explored. Of the 35 students only one is able to make mathematical models to answer questions but the process is less systematic. This shows that mathematical communication skills of the students on the drawing indicator are still low.

Paying attention to the answers, it can be concluded that mathematical communication skills, especially on written text and drawing indicators have not been well explored. According to Libet and Lewinshon in Aufa et al. social skills are complex skills that can strengthen positive or negative behavior [1]. In addition, Schneider that social skills are complex skills involving interaction, both positive interactions and negative interactions [11]. In addition, Goleman social skills include communication, conflict management, leadership, catalyst change, relationship bonding, collaboration and collaboration and team ability [12]. When in a learning environment social skills are very necessary so that students dare to express themselves in expressing ideas and difficulties obtained when looking for solutions to a problem, so that the capabilities they have can be developed optimally. Various learning can facilitate students being trained in mathematical communication skills and social skills, one of which is learning Assurance, Relevance, Interest, Assessment and Satisfaction (ARIAS). As the results of the study Saminan et al. that ARIAS learning can improve the activities and social skills of students and their learning outcomes [13]. Students love learning and respond positively to ARIAS learning. The syntax of ARIAS learning includes: Assurance of trustworthiness and being sure to get a success, Relevance means meaningfulness and relevance, students can be encouraged to learn something if what is learned has relevance to everyday life, Interest means during the learning process takes place the interest of students learning must continue to be maintained not to fade, Assessment or assessment is a process of giving feedback to find out the strengths and weaknesses of students, Satisfaction means pride and satisfaction after achieving success can motivate students to achieve success, providing rewards is one form of reinforcement in learning activities provided by the teacher on student learning outcomes so that it can affect student learning outcomes.

The reason for choosing ARIAS is because Clark et al. suggesting that group discussion is one strategy to develop mathematical communication, when given mathematical problems, students are asked to understand problems and work on solutions in small groups [6]. Another opinion according to Carpenter and Gorg states that when students think, respond, discuss, explain, write, read, listen, and find mathematical concepts, they must do two activities related to communication, namely
communicating to learn mathematics and learning mathematical communication [14]. This study explored the mathematical and social communication skills of students of XI MIPA SMAN 4 in Tasikmalaya City, this study had never been conducted in the City of Tasikmalaya at the secondary school level. This is important, considering that mathematical communication skills and social skills contribute to daily life. The purpose of this study is to analyze the ability of mathematical communication and thinking processes of students in terms of social skills. In addition, the purpose of this study is different from the other, namely finding patterns of mathematical communication thinking processes illustrated in the form of concept map images.

2. Research method
This study used a sequential explanatory combination method, that is the research method whose data collection and analysis consist of two stages, namely quantitative, followed by qualitative. The first step, the data on mathematical communication skills are tested by the mastery learning hypothesis, then the next step is analyzing the answers of the students to find their errors, mathematical communication processes and patterns in terms of their social skills. The population in this study were all students of class XI MIPA of SMAN 4 Tasikmalaya City in the 2017/2018 academic year, randomly sampled 80 students then given treatment using ARIAS learning and at the end of the study were given tests and questionnaires. Data was collected through tests of mathematical communication skills and social skills questionnaires. The research instrument used was a test of mathematical communication skills in the form of a description of 6 questions and a social skills questionnaire consisting of 24 statements. Mathematical communication skills include indicators: written text, drawing and mathematical expressions, using a rubric scale score 4. Indicators of social skills include: actively asking questions and answering questions in discussions, collaborating in groups, respecting opinions from others, and positive attitudes to give and receive criticism in discussions. The choice of statement in social skills consists of positive and negative statements, including: very appropriate, appropriate, inappropriate, very inappropriate. The two instruments were tested empirically for 35 students of class XII MIPA. Test the validity of the instrument using Product Moment correlation with row score, while for reliability use Cronbach Alpha. The results of the calculation of the validity of the 6 questions all are declared valid, and reliability declared reliable. The results of the calculation of the validity of the social skills questionnaire, 21 statements declared valid and 3 statements invalid. Analysis technique for hypothesis testing using proportional test [15]. Process skill data is divided into 3 categories, namely: highly skilled, skilled, and quite skilled. To describe the thinking process of mathematical communication skills in terms of process skills, a student is taken from each group purposively. 3 people were taken, namely S16, S11 and S4 in sequence from each category.

3. Results and discussion
This study applies ARIAS learning to 80th grade XI MIPA high school students, to explore mathematical communication skills and social skills. Mathematical communication skills include indicators: written text, namely explaining ideas, situations and mathematical relations in writing; drawing that states the situation in the form of drawings, diagrams or tables, and mathematical expressions, namely expressing daily events into language, symbols or mathematical models. Social skills include indicators: actively asking questions and answering questions in discussions, collaborating in groups, respecting the opinions of others in discussions and positive attitudes to give and receive criticism in discussions. The data obtained in this study are quantitative and qualitative data, quantitative data regarding mathematical communication skills and social skills, while qualitative data regarding the thinking process of mathematical communication skills are viewed from social skills.

Mastery learning achievement of mathematical communication skills is 92.10% while 7.90% does not reach mastery learning. The mean of mathematical communication skills of the students and percentages on each indicator are presented in the following Table 1. Based on the table, mathematical
communication skills of the students are superior to the mathematical expressions indicator compared to the other two indicators. The student social skills questionnaire consists of 21 statements, social skills of the students consist of highly skilled, skilled, and quite skilled, no less skilled students. Data on social skills of the students are presented in table 2.

| Table 1. Average of each indicator. |
|-------------------------------------|
| Indicators                          | Question | Mean   |
| Written text                        | 1        | 3.18   |
|                                     | 2        | 3.29   |
| Drawing                             | 3        | 2.89   |
|                                     | 4        | 2.87   |
| Mathematical expressions            | 5        | 3.95   |
|                                     | 6        | 3.11   |

| Table 2. Number of Students in Each Category. |
|-----------------------------------------------|
| Score                          | Criteria        | Number |
| 76 – 100                        | Highly Skilled  | 25     |
| 51 – 75                         | Skilled         | 40     |
| 26 – 50                         | Quite Skilled   | 15     |
| 0 – 25                          | Less Skilled    | -      |
| Total                           |                 | 80     |

There are 25 students with highly social skills and they were all achieving mastery learning, and there were only 3 who did not achieve mastery learning out of 40 students in the skilled classification. Whereas only 9 students in the highly skilled classification achieved mastery learning. The results of classical calculations obtained mean social skills so that the social skills of students in ARIAS learning are on skilled criteria. The research hypothesis was tested: Mathematical communication skills using the ARIAS learning model achieved ideal completeness. Hypothesis testing uses the proportion test of one party, with criteria: mathematical communication skills using ARIAS learning achieve ideal completeness when attaining mastery learning at least students get a minimum score of 75. Thus the pair of statistical hypotheses tested: $H_0: \pi \leq 0.8$, $H_1: \pi > 0.8$

For the normality test, the calculation results obtained means that $H_0$ is accepted, meaning that the data on mathematical communication skills come from populations that are normally distributed. Furthermore hypothesis testing, the calculation results obtained by $Z_{count} = 1.87 > Z_{table} = 1.64$ means that $H_0$ is rejected and $H_1$ is accepted, meaning that mathematical communication skills of the students using ARIAS learning achieve ideal completeness. This is in accordance with the results of research Saminan et al. that ARIAS can improve student learning outcomes [13].

The results of the analysis of S16 mathematical communication skills on written text indicators, namely answers to questions number 1 and 2 subjects were able to express ideas, situations and mathematical relations by writing down elements that are known and asked in full. The answer uses two ways, in the first way using the concept of distance but there are errors and the second method uses trigonometric concepts. But on question number 2 the subject does not write down the elements that are known and asked, the calculation process in two ways, using the concept of rectangles and right triangles and the second method using the trapezoidal concept. On the drawing indicator, which is the answer to question number 3, the subject is less able to solve the question completely and correctly, does not list the elements that are known and asked, drawing a graph is incomplete, but is able to use other alternatives in answering using derived concepts. The subject did not understand the question number 4, did not write down the elements that were known and asked so there were errors in drawing circles and balls. Subjects Perform calculation process but inaccurate the end result is wrong. On the indicators of mathematical expressions, answering the question number 5, the subject is able to write down the
elements that are known even though they are incomplete, but do the calculation process correctly equipped with the conclusion. The answer to question number 6 does not write down the elements that are known and asked, there are some symbols that are not clear. To find the thinking process mathematical communication skills of the students from each indicator are analyzed. Figure 4 presents thinking processes of the students in mathematical communication skills.

Figure 1. Process of thinking S16 from highly skilled.
Figure 2. Process of thinking S11 from skilled.

Figure 3. Process of thinking S4 from quite skilled.
White Indicates an Error; Q1, Q2, Q3, Q4, Q5, Q6 (Questions Number 1 to 6); DK, DT (Data that is known and asked); AJ, AT (Algebraic Method, Trigonometry Method); M, G, P (Gradient, Line Equation, Distance Formula); S, T (Large Angle, Tangent Formula); KP, PK (Miscalculation, Conclusion); TG, L1, L2 (high, Area of a Rectangle and triangle, Trapezium Area); K, P : S (Round, Comparison of the Area of a Rectangle and a Triangle); TX, TY, TS (Cut the x Axis, y Axis, Stationary Point); GB, L, LM (picture, Wide Range, Maximum Area); VT, VB, V (Tube Volume, Ball Volume, Derivative); X1 X2, V1 V2, TT (Value X1 X2, Volume 1 volume 2, Tube Height); LP, R (Tube Surface Area, Radius).

The results of the analysis of the answers of the subject S11 on written text indicators are questions number 1 and 2: write down elements that are known in full, use mathematical sentences with sufficiently clear information, stages of systematic calculation, the solution using the concept of distance, the concept of rectangular and broad right angle. Drawing indicators are questions number 3 and 4: do not write down the elements that are known and asked but the process uses the correct concepts and strategies and the results are correct. Indicators of mathematical expressions are questions number 5: do not write down the elements that are known to be complete, the process of systematic calculation is accompanied by drawing conclusions. Answer number 6 subject does not write down the elements that are known and asked in full but the calculation process is complete and correct, this shows that the subject is able to process the information contained in the question.

The results of S4 answer analysis on written text indicators are questions number 1 and 2: write down known but incomplete elements, the calculation process is not systematic and there are errors, the solution uses the concept of distance, the area around the rectangle and the circumference of right triangles. The drawing indicator answers are questions number 3 and 4: do not write down the elements that are known and asked so that the calculation process is incomplete, there should be errors in writing. The mathematical expressions indicator answer, which is question number 5, lists the known but unclear elements and for answers to questions number 6 does not write down the elements that are known and asked, the calculation process is not clear but the final answer is correct.

4. Conclusion

Based on the results of processing and analysis of data, it can be concluded that mathematical communication skills of the students using ARIAS learning achieve ideal completeness. Students in skilled qualifications all achieve mastery learning, while in skilled and sufficiently skilled qualifications, there are still students who have not achieved mastery learning. S16 mathematical communication skills that are in highly skilled qualifications on written text indicators are able to express ideas, situations and mathematical relations equipped with other alternatives in the process of completion and precise calculations but make few mistakes in the calculation process. S11 mathematical communication skills that are in skilled qualifications, in the written text indicator are able to express ideas, situations and mathematical relations equipped with the process of completion and proper calculation but there are errors in the calculation. S4 mathematical communication skills that are in sufficiently skilled qualifications, on the written text indicator have not been able to fully express ideas, situations and mathematical relations, are still in error, so they cannot finish to the end. Based on the results of the study, the researcher recommends that in everyday learning teachers should use ARIAS learning as an effort to improve mathematical communication skills and social skills. In addition, ARIAS learning allows the students to be active and enjoy learning mathematics.

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References

[1] Aufa M, Saragih S and Minarni A 2016 Development of Learning Devices through Problem Based Learning Model Based on the Context of Aceh Cultural to Improve Mathematical Communication Skills and Social Skills of SMPN 1 Muara Batu Students. J. Educ. Pract. 7 232–48

[2] National Council of Teachers of Mathematics 2000 Principles and standards for school mathematics 1 (Reston, VA: National Council of Teachers of Mathematics)

[3] Johar R, Junita E and Saminan 2018 Students’ Mathematical Communication Ability and Self-Efficacy using Team Quiz Learning Model Int. J. Emerg. Math. Educ. 2 203–14

[4] Hirschfeld-Cotton K 2008 Mathematical Communication, Conceptual Understanding, and Students’ Attitudes Toward Mathematics Action Res. Proj. 4 54

[5] Yusra D and Saragih S 2016 The Profile of Communication Mathematics and Students’ Motivation by Joyful Learning-based Learning Context Malay Culture Br. J. Educ. Soc. Behav. Sci. 15 1–16

[6] Clark K K, Jacobs J, Pittman M E and Borko H 2005 Strategies for building mathematical communication in the middle school classroom: Modeled in professional development, implemented in the classroom Curr. Issues Middle Lev. Educ. 11 1–12

[7] Qohar A and Sumarmo U 2013 Improving Mathematical Communication Ability and Self Regulation Learning Of Yunior High Students by Using Reciprocal Teaching IndoMS J.M.E 4 59–74

[8] Elliott P C and Kenney M J 1996 Communication in Mathematics, K-12 and Beyond. 1996 Yearbook (Reston, VA: National Council of Teachers of Mathematics)

[9] Baroody A J and Coslick R T 1993 Problem solving, reasoning, and communicating, K-8: Helping children think mathematically ed L J Scharp (New York, NY: Mcmillan Publishing Company)

[10] Alhaddad I, Kusumah Y S, Sabandar J and Dahlan J A 2015 Enhancing students’ communication skills through Treffinger teaching model J. Math. Educ. 6 31–9

[11] Pekdogan S 2016 Investigation of the Effect of Story-Based Social Skills Training Program on the Social Skill Development of 5-6 Year-Old Children Online Submiss. 41 305–18

[12] Matthews G, Zeidner M and Roberts R D 2004 Emotional intelligence: Science and myth (MIT press)

[13] Saminan, Tarmizi H and Nafilah R 2017 The Implementation of ARIAS Learning Model Integrated with Constructivist Theory to Improve Students’ Learning Outcomes Jurnal Ilmiah Peuradeun 5 213–224

[14] Carpenter J and Gorg S 2000 Principles and Standards for Mathematical School (Reston, VA: National Council of Teachers of Mathematics)

[15] Minium E W, King B M and Bear G 1993 Statistical reasoning in psychology and education (New York, NY: John Wiley & Sons, Inc.)