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The Students' Mathematical Communication Skills Based on The Levels of Self-Awareness

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Abstract

Mathematical communication is one of the important skills that students should possess. This mathematic communication skill belongs to the cognitive realm and is influenced by the affective one, one of which is self-awareness. Thus, this study is aimed at finding out the students' mathematical communication skills based on the subjects' self-awareness. The subjects of this study are the students of the Mathematics Education Program in one of the private universities in Indonesia. The instruments of the study are a mathematical communication skill test, interview guidelines, and a questionnaire on self-awareness. The results of the study revealed that the students of the High and Medium self-awareness categories were able to find a way to finish the questions of the linear program in all indicators, namely mathematical expression indicator, drawing, and writing. In the first indicator in the Low self-awareness category, the subjects were able to make a mathematic model in the form of a system of linear inequalities. In the second indicator, drawing, the subjects could not perform the completion stage by counting every angle in the solution set area.

Keywords: Mathematical communication, mathematic modeling, self-awareness

1. INTRODUCTION

Communication is an attempt to convey messages, ideas, or information from communicators to communicants, and vice versa. Mathematical communication skills are compulsory to nurture so that students can get involved in learning and avoid the assumption that mathematics is a difficult and scary subject to learn [1]. Communication is the ability that should be mastered by all students in all subjects, not only in mathematics. Besides the fact that communication is important in all subjects, it is also important in real life. Thus, the skill of communication in mathematics is important for the students [2].

Communication plays an important role in the learning process, including in learning mathematics [3]. In Mathematics Education, the ability to communicate is one of the skills needed by the students [4]. Mathematical communication is one of the skills needed by the students [5]. The student's cognitive skill is one of the mathematical communication skills [6].

Mathematics as a subject has a special way of communicating mathematics [7]. Mathematical communication is acceptable generally in various fields. Mathematical understanding and communication are the things that are noticed globally. In various countries, teachers and scientific organizations have explicitly identified communication competence as one that is needed for scientific literacy in the twenty-first century [8].

Language and other forms of communication support the representation improvement of students, which becomes a basic to build their mathematic knowledge [9]. Mathematical communication skill is important for students because it leads them to mathematical problem-solving by using good reasoning, describing mathematic ideas into mathematic models, and relating the process to various concepts of mathematics in the contexts of daily life and other disciplines [3]. One of the important purposes of studying mathematics is to develop individuals to implement mathematics in daily life and solve problems in real life [10].

Considering the importance of mathematical communication skills, it is important to create a learning environment that can support mathematical communication [11]. Language and communication are regarded as the main components in the teaching and learning of mathematics. However, there is an unanswered question about the connecting feature among language, mathematics, teaching, and learning. Encouraging communication during learning can occur by giving support and questions that are specially designed for the

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students to communicate in oral and written modes through discussions, sharing ideas among the students, and writing assignments.

According to some experts, it is concluded that mathematical communication skill is an important skill both in mathematics subject and in other subjects. A good mathematical communication skill enables the students to give arguments to outline ideas of mathematics into mathematic models and connect these processes to various concepts of mathematics, everyday life, and other discipline contexts. Mathematical communication skills can be developed or improved through learning that encourages students to communicate both orally and in written mode through discussions, sharing ideas among the students, and working on assignments.

Along with the definition of the mathematical communication skill, the indicators used to see the mathematical communication ability are different as well. Three sub-themes appeared from the most used concepts by teachers to define mathematical communication: (a) mathematic understanding, (b) the use of mathematics in a real-life context, and (c) the use of mathematic language [11]. Furthermore, the three skills that are assessed in the mathematical communication skill are: 1. Writing (written text), which means describing ideas or solutions to a problem by using one's language. 2. Da1rawing, which means explaining ideas or solutions to a problem in the form of drawing. 3. Mathematic expression, which means explaining the problems or daily events in mathematic model language [12]. Therefore, this study employs the indicators of 1. Writing (written text);2. Drawing; 3. Mathematic expression.

Cognitive competence is influenced by the affective domain, and the affective domain is one of the objectives of learning mathematics. Self-awareness belongs to the affective domain that has a great impact and tight correlation to the student's ability to solve problems given by the lecturers to find out to what extent the students can solve them responsibly.

Self-awareness in everyday life has some features visible to the personality, as stated by Solso that the self-awareness features include the attention aspect, wakefulness, architecture, remembering knowledge, and emotions [13]. Self-awareness in mathematics learning has to be paid attention to as well because every kind of task should be based on self-awareness [14]. Parek stated that the one with a high self-awareness will possess a value system in himself, thus he can reflect on and control himself so that he performs the behavior that is appropriate with his positive thinking [15]. The ability to control oneself in self-awareness affects the form of communication with others. Thus, the problem statement of the current study is "How was the students' mathematical communication skill based on the levels of self-awareness of High, medium, and low levels?".

2. METHODS

Research Subjects

The subjects of this study were the students of the Mathematic Education Program at one of the private universities in West Java province. The subjects consisted of thirteen students who participated in the mathematic competence test and completed a self-awareness questionnaire. As the triangulation research method, in the interview phase, six subjects participated considering that two subjects had a high level of self-awareness, two subjects had a medium level of self-awareness, and the last two subjects had a low level of self-awareness.

Research instruments

There were three instruments used in this study, as elaborated as follows.

1) The mathematical communication skill test consists of three questions appropriate to the mathematical communication indicators being tested. The test was in an essay form. The test questions were previously tried out by using tests of validity, reliability, appropriateness, and level of difficulty. This is aimed at achieving the appropriate instruments of the study.
2) The self-awareness questionnaire was used to find out the levels of the student's self-awareness. The questionnaire had statements that should be answered "yes" or "no", then "strongly agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). Each item had a minimum score of 1 and a maximum score of 5.

TABLE 1. Self-awareness Questionnaire Items

Number	Indicators	Statements	Statement form
1	The students' understanding of the mathematic perception	1,2	Positive (+)
2	The students' point of view of the importance of mathematic	3,4,5,6	Positive (+)

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3	The students' motivation revealed to solve mathematic problems	7,8,9,10	Positive (+)

Source: [16]

This Questionnaire was one of the measurements used in this study to measure the levels of the student's self-awareness based on the indicators of self-awareness, presented in 10 questions stated in the questionnaire. The category of measuring the self-awareness category of the students was as follows.

TABLE 2. Self-awareness Questionnaire Category

Number	Category	Final Grade
1	Low	≤ 35
2	Curent	35 – 39
3	High	≥ 40

Source: [16]

3) Interview Guidelines was one of the instruments in this study because the interview was in a semi-structured form. A semi-structured interview is an interview that belongs to an in-depth interview. In practice, it is freer than the structured interview [17]. This interview guideline was developed by the writer, in the form of questions to dig into the study subjects' mathematical communication skills. The interview was conducted after the result of the mathematical communication skill had been found out.

3. FINDINGS AND DISCUSSION

1) High level of Self-awareness

a. Subject AL

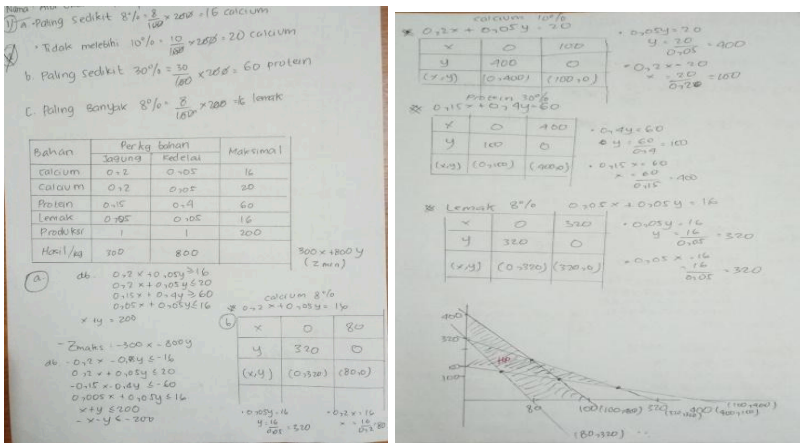

Figure 1. Answer to Question number 1 on the Subject AL

Question number 1a is a mathematic expression indicator that states the problems or events in daily life in the mathematic model language. The results of the interview revealed that Subject AL conducted the first step, called information decoding, to complete important information needed for the mathematic model. After obtaining the results of counting aimed at completing the necessary information, the subject constructed the mathematical model in the form of a linear inequality system.

Question number 1b implementing a drawing indicator explained ideas or mathematic problem solving in the form of drawing. The AL subject referred to the results of the linear program model creation obtained in question number 1a, which later was presented in the form of a graphic by marking the solution set area.

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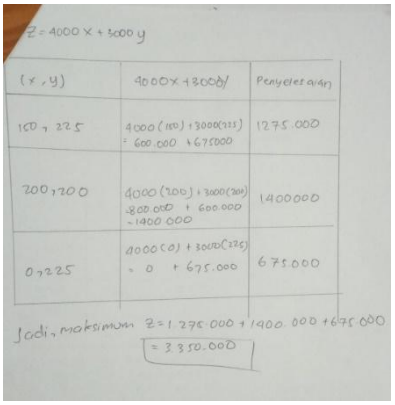

Figure 2. Answer to Question number 2 on the Subject AL

The answer to question number 2 and the results of the interview revealed that the subject had conducted the completion stage by counting each angle in the deposition area.

b. Subject S1

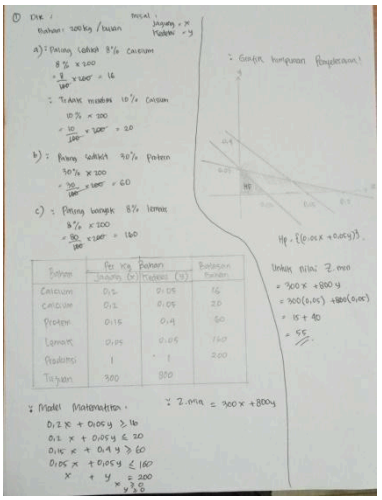

Figure 3. Answer to Question number 1 on the Subject S1

Question number 1a is a mathematic expression indicator that states the problems or events in daily life in the mathematic model language. The result answers and the results of the interview revealed that the Subject AL conducted the steps to detail the necessary information first to complete the necessary important information to create a mathematic model. After obtaining the counting results to complete the necessary information, the subject further constructed a mathematical model in the form of a linear inequality system.

On question number 1b, by using a drawing indicator, the subject explained the ideas or mathematic problem-solving in the form of a drawing. The AL subject referred to the results of creating a linear program model obtained in question number 1a, which later was presented in the form of a graphic by marking the solution set area.

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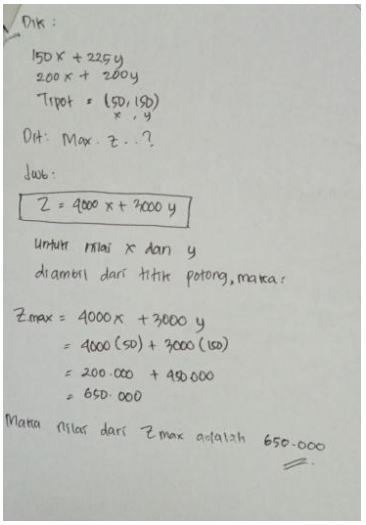

Figure 4. Answer to Question number 2 on the Subject S1

Based on the results of number 2, with the indicator of medium for written text, which explained ideas or problem-solving by using his language, it could be seen that the subject had conducted the completion stage by counting each angle in the determined solution set area.

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2) Self-awareness in the Medium level subjects

a. Subject LA

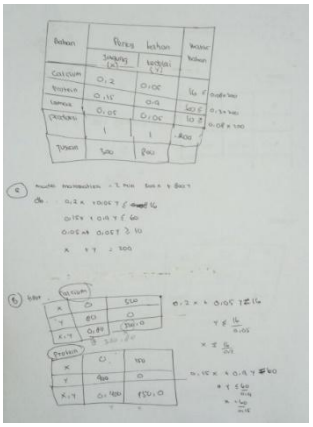

Figure 5. Answer to Question Number 1 on the Subject LA

Question number 1 was a mathematical expression indicator that presented the problems or the daily events in the mathematic model language. The results of the interview showed that the subject AL had attempted to elaborate on the information in the first place to complete the important information necessary for making a mathematic model. The decoding process of the information did not succeed so the subject could not obtain complete information. The subject was unable to construct the mathematical model of the linear inequality system.

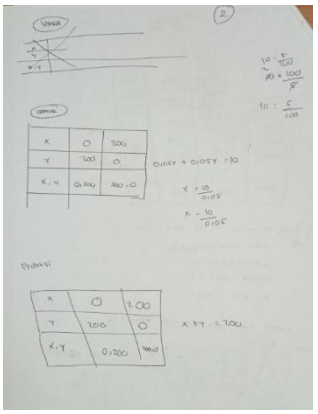

Figure 6. Answer to Question Number 1 on the Subject LA

Question 1b employed the drawing indicator. It explained the ideas or the mathematic problem-solving in the form of a drawing. The results of the interview revealed that the subject could not refer to the results of creating a linear program model obtained in question number 1a because he failed to create the mathematical model. Thus, this affected the graphic and the solution set he created

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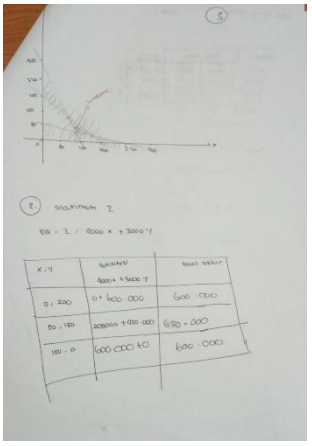

Figure 7. Answer to Question Number 2 on the Subject LA

Based on the results of number 2, with the indicator of medium for written text, which explained ideas or problem-solving by using his language, it could be seen that the subject had conducted the completion stage by counting each angle in the determined solution set area.

b. Subject EF

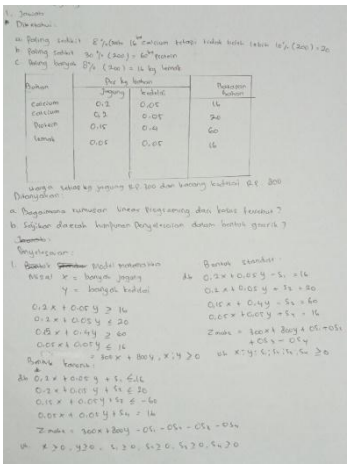

Figure 8. Answer to Question Number 1 on the Subject EF

Question number 1 was a mathematical expression indicator that presented the daily problems or events in the language of the mathematic model. The results of the interview showed that the Subject AL attempted to elaborate the information in the first place to be able to complete the necessary information for making a mathematic model. This information decoding process was successful so that complete information was obtained.

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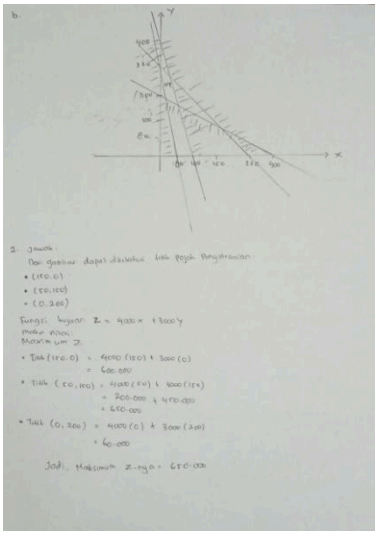

Figure 9. Answer to Question Number 2 on the Subject EF

Question 1b employed the drawing indicator. It explained the ideas or the mathematic problem-solving in the form of a drawing. The main discussion referred to the results of linear program model creation obtained in question 1a. The subject had successfully created the graphic and revealed the solution set. Based on the results of number 2, with the indicator of medium for written text, which explained ideas or problem-solving by using his language, it could be seen that the subject had conducted the completion stage by counting each angle in the determined solution set area.

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3) Self-awareness in the Low-level subjects

a. Subject SA

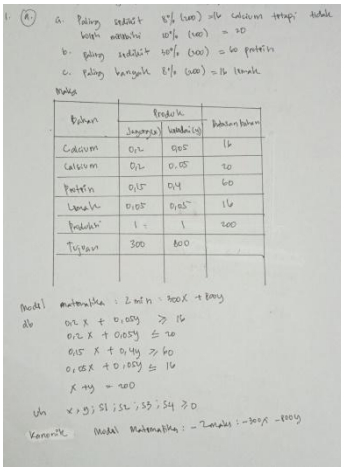

Figure 10. Answer to Question Number 1 on the Subject SA

Question number 1a was a mathematic expression indicator that presented daily problems and events in the language of the mathematic model. The results of the interview revealed that the subject AL had attempted several steps to elaborate the information in the first place to be able to complete the important information necessary for creating the mathematical model. The decoding process was successful so that the complete information could be obtained. The subject was successful in constructing the mathematical model in the form of a linear inequality system.

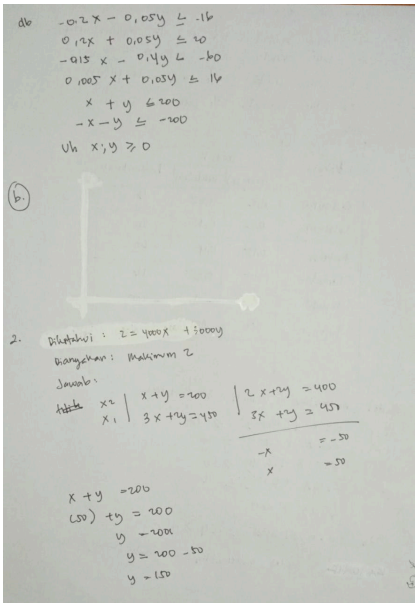

Figure 11. Answer to Question Number 2 on the Subject SA

Question 1b employed the drawing indicator. It explained the ideas or the mathematic problem-solving in the form of a drawing. The subject could not create the graphic requested in the question. Based on the result of question number 2, implementing the written text indicator by explaining the ideas or the completion of a problem or a drawing using his language, it could be seen that the subject failed to make count on each angle on the graphic on the determined question.

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b. Subject VW

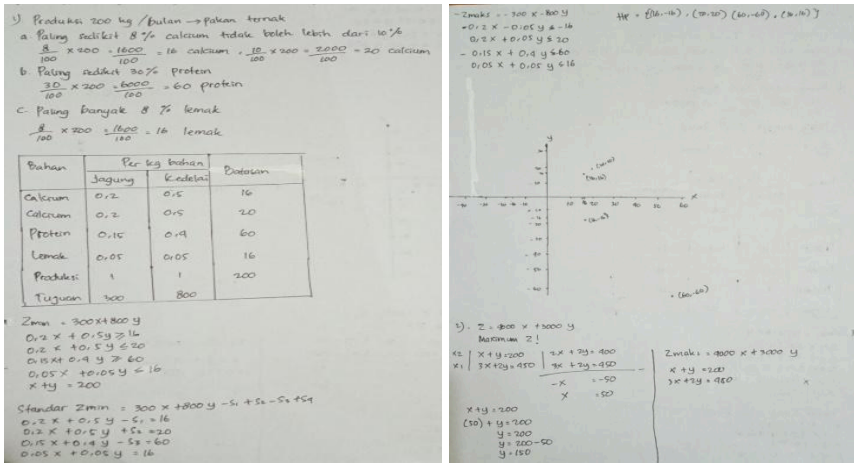

Figure 12. Answer to Question Number 2 on the Subject of VW

Question number 1a was a mathematic expression indicator that presented daily problems and events in the language of the mathematic model. The results of the interview revealed that the subject AL had attempted several steps to elaborate the information in the first place to be able to complete the important information necessary for creating the mathematical model. The decoding process was successful so that the complete information could be obtained. The subject was successful in constructing the mathematical model in the form of a linear inequality system.

Question 1b employed the drawing indicator. It explained the ideas or the mathematic problem-solving in the form of a drawing. The subject could not create a graphic. Based on the result of question number 2, implementing the written text indicator by explaining the ideas or the completion of a problem or a drawing using his language, it could be seen that the subject was not successful in completing the problem in question number 2.

TABLE 3. Description Of Mathematical Communication Skill Based On Self-Awareness

Self-awareness Category	Indicators		
	Mathematic Expression	**Drawing**	**Writing**
High	Conducted the steps of elaborating information in the first place to complete the important information necessary for creating a mathematical model. After obtaining the counting results to complete the necessary information, the subject constructed a mathematical model in the form of a linear inequality system.	Referring to the results of creating a linear program model obtained in question number 1a, the subject presented them in the form of a graphic by marking the solution set area.	The subject conducted the steps of completion by counting each angle in the settlement area.
Medium	The subject elaborated on the information first to complete the important information necessary for creating a mathematical model. The decoding process was successful so the subject obtained complete information. The subject was successful in constructing the mathematical model in the form of a linear inequality system.	The results of creating the linear programming model in question number 1a were used as the basis for creating a graphic so that the graphic was successfully created. The subject was able to reveal the solution set.	The subject conducted the completion stages by counting each angle in the solution set.
Low	The subject attempted to elaborate the information first to complete the important	The subject was unsuccessful in creating the graphic.	The subject was unsuccessful in solving the problem.

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Self-awareness Category	Indicators		
	Mathematic Expression	Drawing	Writing
	information needed for creating a mathematical model. The decoding process was successful so that the subject could obtain complete information. The subject was successful in constructing the mathematical model in the form of a linear inequality system.		

4. CONCLUSION

Based on the results of the study, it can be concluded that the subject in the High category of self-awareness for the mathematic expression indicator conducted the elaboration of information to complete the important information needed for creating the mathematic model in the form of a linear inequality system. On the second indicator, the drawing, it was revealed that the core of the discussion referred to the results of creating a linear program model obtained in question number 1a, which later was presented in the form of a graphic by marking the solution set area. However, in the writing indicator, the subject conducted the completion procedures by counting each angle in the deposition area.

The subject in the medium category of self-awareness, in the mathematical expression indicator, conducted the elaboration of information to complete important information needed in creating the mathematical model in the form of a linear inequality system. In the second indicator, the drawing indicator, the subject referred to the creation of a linear program model obtained in question number 1a, which later was presented in the form of a graphic by marking the solution set area. Whereas, in the Writing indicator, the subject completed the procedures by counting each angle in the deposition area.

The subject in the Low category of self-awareness, in the mathematical expression indicator, conducted the elaboration of information to complete the important information needed to create a mathematical model in the form of a linear inequality system. In the second indicator, the drawing indicator, the subject was unable to present it in the form of a graphic. However, in the writing indicator, the subject was unsuccessful in completing the procedures by counting each angle in the deposition area.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] R. A. Kusuma and J. T. Manoy, “Mathematical Communication of Students in Completing SPLTV in Terms of Mathematical Ability,” *MATHEdunesa*, vol. 11, no. 1, pp. 243–254, 2022, doi: https://doi.org/10.26740/mathedunesa.v11n1.p243-254.

[2] C. Chasanah, Riyadi, and B. Usodo, “The effectiveness of learning models on written mathematical communication skills viewed from students’ cognitive styles,” *Eur. J. Educ. Res.*, vol. 9, no. 3, pp. 979–994, 2020, doi: 10.12973/EU-JER.9.3.979.

[3] G. M. Tinungki, “The Role of Cooperative Learning Type Team Assisted Individualization to Improve the Students’ Mathematics Communication Ability in the Subject of Probability Theory,” *Proc.of fifth Conf. Psychol. Math. Educ.*, vol. 6, no. 32, pp. 27–31, 2015, [Online]. Available: https://eric.ed.gov/?id=EJ1083611

[4] R. A. Nartani, C Indah, Hidayat and Y. Sumiyati, “Communication in Mathematics Contextual,” *Int. J. Innov. Res. Educ. Sci.*, vol. 2, no. 4, pp. 2349–5219, 2015.

[5] M. Triana, C. M. Zubainur, and B. Bahrun, “Students’ Mathematical Communication Ability through the Brain-Based Learning Approach using Autograph,” *JRAMathEdu (Journal Res. Adv. Math. Educ.*, vol. 4, no. 1, pp. 1–10, 2019, doi: 10.23917/jramathedu.v4i1.6972.

[6] K. S. Asih, Isnarto, and Sukestiyarno, “Mathematical Communication Skills Reviewed From Mathematical Resilience in Independent Learning and Discovery Learning Assisted by E-Learning,” *Unnes J. Math. Educ. Res.*, vol. 10, no. 2, pp. 112–120, 2021, [Online]. Available: http://journal.unnes.ac.id/sju/index.php/ujmer

[7] B. Aineamani, “How Learners Communicate Their Mathematics Reasoning in Mathematics Discourse,” pp. 65–74, 2018, doi: 10.1007/978-3-319-75055-2_6.

QRCBN 62-6861-0508-697
https://proceeding.unnes.ac.id/icmse

[8] Y. Chung, J. Yoo, S. W. Kim, H. Lee, and D. L. Zeidler, "Enhancing Students' Communication Skills in the Science Classroom Through Socioscientific Issues," *Int. J. Sci. Math. Educ.*, vol. 14, no. 1, pp. 1–27, 2016, doi: 10.1007/s10763-014-9557-6.

[9] G. Kent, *Language and communication in mathematics education: international perspectives*, vol. 21, no. 3. Springer International Publishing, 2019. doi: 10.1080/14794802.2018.1563562.

[10] E. Saka and S. Alkan, "Examining the secondary school mathematics practices course books in Turkey according to the principles of the model eliciting activity design," *Int. J. Curric. Instr.*, vol. 14, no. 1, pp. 523–542, 2022, [Online]. Available: http://ijci.wcci-international.org/index.php/IJCI/article/view/885

[11] D. Kaya and H. Aydin, "Elementary mathematics teachers' perceptions and lived experiences on mathematical communication," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 12, no. 6, pp. 1619–1629, 2016, doi: 10.12973/eurasia.2014.1203a.

[12] H. Hodiyanto, "Kemampuan Komunikasi Matematis Dalam Pembelajaran Matematika," *AdMathEdu J. Ilm. Pendidik. Mat. Ilmu Mat. dan Mat. Terap.*, vol. 7, no. 1, p. 9, 2017, doi: 10.12928/admathedu.v7i1.7397.

[13] W. Kusumaningsih, S. Supandi, and L. Ariyanto, "Ethnomathematics for congruence concept: A didactical design in a mathematics classroom," *J. Phys. Conf. Ser.*, vol. 1663, no. 1, 2020, doi: 10.1088/1742-6596/1663/1/012036.

[14] I. Nuraida and Y. Sunaryo, "Implementasi Pembelajaran Student Facilitator and Explaining untuk Menumbuhkan Sikap Self-Awareness Siswa SMA," *Edutainment J. Ilmu Pendidik. dan Kependidikan*, vol. 1, no. 1, pp. 23–25, 2017.

[15] A. Riyadi and H. Hasanah, "Pengaruh Self-awareness Dan Kematangan Beragama Terhadap Komitmen Organisasi Karyawan Rsud Tugurejo Semarang," *Psympathic J. Ilm. Psikol.*, vol. 2, no. 1, pp. 102–112, 2016, doi: 10.15575/psy.v2i1.451.

[16] M. O. Hilapok, *Self awareness dan implikasinya pada usulan topik program pengembangan diri (Studi Deskriptif pada mahasiswa Program Studi Bimbingan dan Konseling angkatan 2014 Universitas Sanata Dharma Yogyakarta)*. Yogyakarta: Yogyakarta: Universitas Sanata Dharma, 2017.

[17] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Bandung: Alfabeta, 2017.