# The Effect of Mathematical Literacy Ability, Critical Thinking Ability, and Mathematical Communication Ability on the Mathematical Problem Solving Ability

Almas Adlina[1], Edi Syahputra[2], Pardomuan Sitompul[3]

almasadlina4321@gmail.com[1]

[123]Postgraduate Mathematical Education, Universitas Negeri Medan, Indonesia

**Abstract.** The objectives of this study are: to examine how mathematical literacy skills, critical thinking skills, and mathematical communication skills simultaneously and partially influence the ability to solve mathematical problems. A quantitative research approach was used in this study. The study was conducted in SMPS Bina Taruna Medan, SMPN 20 Medan, and SMPN 32 Medan. The subjects of 90 students in her class VII-1 from three schools. The sampling method in this study was random sampling technique. The instrument used consists of test literacy mathematical ability, critical thinking ability, mathematical communication ability, and mathematical problem solving ability. Data analysis was performed using multiple regression analysis. Mathematics literacy, critical thinking, and mathematical communication skills simultaneously influence 90.1% of mathematical problem-solving ability, while 9.9% is determined by other variables.

**Keywords:** Mathematical Literacy Ability, Critical Thinking Ability, Mathematical Communication Ability, Mathematical Problem Solving Ability

## 1 Introduction

Mathematics is a fundamental problem and very important for life. Learning mathematics at school is expected to help students become more creative, flexible, collaborative, problem solving and innovative in the future. By studying mathematics, students are expected to improve mathematical literacy, critical thinking skills, communication skills, and Ability to solve mathematical problems.

Mathematical literacy as defined in PISA, is the ability to reason mathematically and formulate and apply mathematics in various situations, including the ability to describe, explain or predict phenomena/events using concepts, procedures and facts [1]. Mathematical knowledge is not only necessary to master content, but also to use reasoning, concepts, facts, and mathematical tools to solve everyday problems. Therefore, mathematical ability is a skill needed to be able to face problems in everyday life.

Critical thinking is a higher order thinking skill. According to Johnson, Critical thinking is a clearly organized process used in mental activities such as solving problems, making decisions, persuading, analyzing hypotheses, and conducting scientific research activities [2]. Mathematical critical thinking is one of the goals of mathematics learning and is defined as a basic thinking process for analyzing hypotheses and generating ideas for existing situations, with the aim of encouraging logical thinking. Critical thinking skills also enable students to formulate problems correctly, gather and evaluate relevant information, and communicate

ICoSTA 2023, November 02, Medan, Indonesia
Copyright © 2024 EAI
DOI 10.4108/eai.2-11-2023.2343261

effectively with others to find solutions to complex problems. This shows that critical thinking chops are veritably important for students to train their ability to understand more complex information provided and make important decisions both in learning and in everyday life. This will allow students to socialize, solve scientific problems, and effectively solve practical problems in the future.

Mathematical communication chops are scholars' capability to organize and combine fine thin king communicatively. scholars' capability to communicate their ideas logically and easily to musketeers, preceptors and other people [3]. In agreement with the statement Wijayanto, that fine communication chops really need to be developed in mathematics literacy, communication chops are veritably important [4]. Because through fine communication, scholars can organize their fine thinking both orally and in jotting. The National Council of preceptors of Mathematics (NCTM) has established four norms for fine communication chops that scholars must achieve. 1) Communicate your fine thinking constantly and easily to classmates, preceptors, and others. 2) dissect and estimate other people's fine thinking and strategies. 3) Using fine language to express fine generalities directly.

The capability to break fine problems is an important fine skill that scholars who study mathematics must master. The verity of this statement is that working fine problems is a skill listed in the class and mathematics literacy objects [5]. By learning fine problem working chops, scholars are anticipated to gain experience using the knowledge and chops they've applied. Mathematics learning points not only to ameliorate scholars' chops in working problems related to computations in numerical form, but also to ameliorate scholars' chops in working problems that use mathematics contextually. The significance of problem working chops was stressed by Fauziah, who showed that problem working chops are one of the fine chops which can be classified as advanced position chops [6]. Likewise, the significance of problem working chops was also stressed by Pimta, who stated that problem working chops can be answered by scholars understanding the being problems and how scholars break them an idea of what to do break the problem [7].

## 2 Riview Of Literature

2.1 Mathematical Literacy Ability

Literacy comes from English and refers to the ability to read and write. The ability to read and write is still the most important skill needed to carry out daily life. Because without literacy, it is difficult to advance communication between humans to a higher level. The term literacy refers to language skills which include the ability to listen, speak, read, write and think [8]. Literacy has become a very hot topic in international discussions and is a big goal and ambition of the young generation in every country. Mathematical literacy consists of mathematical reasoning abilities, use of concepts, ability to apply procedures, ability to find facts and find mathematical tools to describe, depict and evaluate events [9].

In simple terms, mathematical literacy is a student's ability to understand mathematical concepts, use mathematics to solve life problems, including mathematical thinking, problem solving, mathematical communication, and the use of mathematics in everyday life. This process requires the ability to think mathematically, starting with identifying and understanding the problem. Mathematical literacy means being able to read, listen, write and speak and have mathematical knowledge that can be used for understanding, problem solving and communication.

## 2.2 Critical Thinking Ability

The more you learn based on your discoveries and deepen the concept of the material, the more meaningful your knowledge will be. To think critically, you need to read critically so that your decisions are not wasted. Critical thinking is one of the important chops when learning mathematics. Critical thinking has numerous different terms and is defined by different experts using different expressions, but the meaning is the same. According to Purwanto, he expresses the meaning of thinking in relation to a more general framework, namely abstraction, while he expresses it in relation to a more specific framework, namely abstractions such as reactions, memories, memory, and so on [10]. It is said that this is thought about in the arrangement or study of interrelationships. understanding and emotion. Thoughts are definitely related to various problems, whether they arise from the present, the past, or those that don't yet exist. The problem solving process is called the thinking process. Critical thinking skills are required to make holistic decisions. These skills include the ability to provide simple explanations, build basic skills, formulate, provide further explanations, and manage strategies and tactics [5].

Based on the opinions of several experts mentioned above, the definition of critical thinking ability, namely anyone who includes analysis and evaluation of ideas and ideas in a more specific direction in order to obtain relevant knowledge about the world, can be drawn conclusions regarding the competencies that must be possessed. To get proof. Critical thinking skills are very important for analyzing problems and finding solutions.

## 2.3 Mathematical Communication Ability

Pratiwi states that fine communication is a system of communicating ideas, strategies and fine results to break problems, both written and verbal [11]. Meanwhile, according to Nofrianto, fine communication chops can be interpreted as scholars' capability to communicate what they know through dialogical events and connections that do in the classroom and where dispatches are conveyed back and forth [12]. Mathematical communication chops are veritably important in the process of transmitting information, ideas and fine generalities between scholars and preceptors, scholars and books. If the end of the process is to insure that the people communicating have the same view or point of view and can communicate it orally or in jotting. In fine communication, you're anticipated to be suitable to present the results of your thinking, break problems and dissect and compare meaning. Thus, fine communication can be said to be a tool for working fine problems and a medium for social commerce [13].

From the opinions and findings above regarding fine communication, we can conclude that fine communication means conveying giving fine ideas from the results of allowing about fine problems, which consists of oral and spoken communication. Oral communication is analogous to discussion and explanation, while written communication is the expression of fine ideas through filmland, graphs, tables, equations, or in the scholars' own language.

## 2.4 Problem Solving Ability

In everyday life, humans are never free from problems ranging from simple to complex. People who are used to facing problems will find it easier to solve the same problem when faced with that problem. On the other hand, it may be difficult for people who are not used to solving problems. Nitko said that problem solving is an effort to achieve a desired goal and not necessarily knowing the right way to achieve that goal, but Sumarmo revealed that problem solving is a process to alleviate difficulties [14]. To achieve a desired goal. According to this narrative, problem solving is an effort to achieve the expected goals through basic processes and skills. According to Polya in Hudojo, there are two types of mathematics,

namely problems that must be discovered and problems that must be proven. The problem found is a mathematical problem based on data, conditions and objects used to solve the problem. The problem to be proven is a mathematical problem. The solution is to use the assumptions and conclusions contained in the sentence to prove that the sentence is true.
Based on the explanations of the experts above, mathematical problem solving ability is a student's ability to find ways to solve problems or develop new ideas and methods according to the problems they face in everyday life, we can conclude that.

## 3 Method

The end of this exploration is to determine the influence of introductory fine knowledge, critical thinking chops, and fine communication chops on scholars' contemporaneous and partial fine problem working capacities. This exploration uses a quantitative approach and the nature of the exploration is ex post facto, videlicet examining interacting connections, manipulating variables and data collected in this exploration after or at the time of the incident, nothing needs to be done or reused. This exploration aims to examine the influence of three variables fine capability (X1), critical thinking capability (X2), and fine communication capability (X3) on problem working capability (Y).
This research was conducted in three junior high schools in the city of Medan. The first is SMPS Bina Taruna Medan located on Jl. Marelan Raya Pasar III no. 100 Rengas Pulau Kec. Medan Marelan. The second is SMP Negeri 20 Medan located on Jl. Kapten Rahmad Buddin Lk. 14, Terjun Kec. Medan Marelan. The third is SMP Negeri 32 Medan located on Jl. Marelan V No. 123, Rengas Pulau Kec. Medan Marelan. This research was conducted in the odd semester of the 2023/2024 academic year.
The sample selection in this study used a cluster random sampling technique which divides the population into several groups (clusters), so that this study randomly selected two state schools and one private school in Medan City, consisting of junior high schools. Next, Class VII from the three schools was used as the research sample. The instrument used in this research is a descriptive test. The data analysis techniques used in this research are prerequisite testing, multiple regression models, correlation analysis, and coefficient of determination. This test uses SPSS 26.0. The form of research design is as follows:

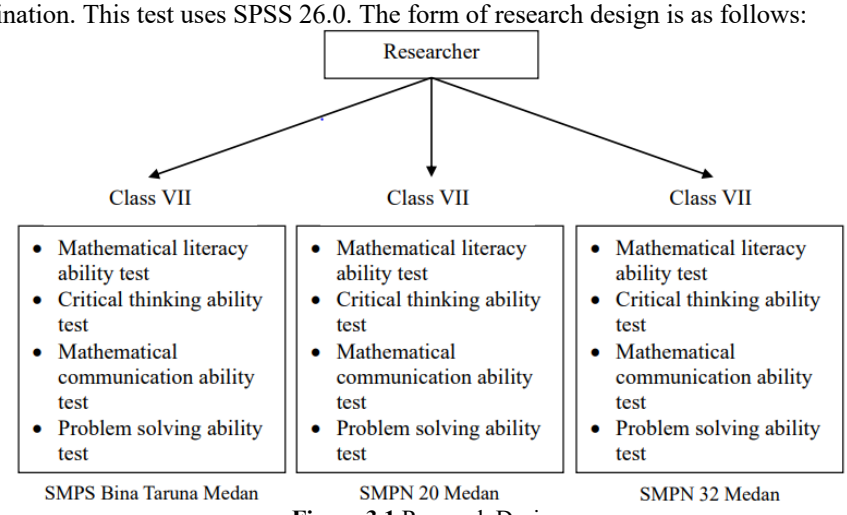


**Figure 3.1** Research Design

## 4 Research Result

The resulting data will be quantitative data. Through this research, a lot of data was obtained, including: 1) Results of students' mathematical literacy ability tests. 2) Test the results of students' critical thinking abilities. 3) test results of students' mathematical communication skills, and 4) results of tests of students' problem solving abilities. The data described in this research include the Student Mathematical Literacy Ability Test (X1), the Student Critical Thinking Ability Test (X2), the Student Mathematical Communication Ability Test (X3), and the Student Problem Solving Ability Test (Y). There are 90 students at the public and private junior high school level in Medan City.

The performing data will be quantitative data. Through this exploration, a lot of data was attained, including: 1) Results of scholars' fine knowledge capability tests. 2) Test the results of scholars' critical thinking capacities. 3) test results of scholars' fine communication chops, and 4) results of tests of scholars' problem working capacities. The data described in this exploration include the Student Mathematical knowledge Capability Test (X1), the Pupil Critical Allowing Capability Test (X2), the Student Mathematical Communication Capability Test (X3), and the Pupil Problem working Capability Test (Y). There are 90 scholars at the public and private inferior high academy position in Medan City. The computation results are shown in the following table:

**Table 1** Summary of Results of Research Variable Values

| Statistic | $X_1$ | $X_2$ | $X_3$ | Y |
|---|---|---|---|---|
| Lowest Score | 43,75 | 48,43 | 55,5 | 58,24 |
| Highest Score | 93,75 | 96,86 | 94,35 | 95,68 |
| Mean | 76,944 | 79,344 | 79,488 | 80,449 |
| Std. Deviation | 12,514 | 10,317 | 8,798 | 8,906 |

### 4.1 Multicolinearity Test

The multicollinearity test in this study is based on the use of SPSS 26.0 and considers variance inflation factor (VIF) and collinearity tolerance using the following assumptions:

$H_0$ : multicollinearity doesn't do

Ha : multicollinearity occurs

The test criteria are:

- If VIF $\leq$ 10 and Forbearance value $\geq$ 0.10 there is no multicollinearity between the independent variables
- If VIF $\geq$ 10 and Forbearance value $\leq$ 0.10 there is multicollinearity between the independent variables

**Table 2.** Multicollinearity Test Results

| Coefficients[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardlized Coefficients Beta | t | Sig. | Collinearity Statistics | |
| | | B | Std. Error | | | | Tolerance | VIF |
| 1 | (Constant) | 8.550 | 3.357 | | 2.547 | .013 | | |
| | Mathematical literacy | .037 | .054 | .052 | .692 | .491 | .282 | 3.549 |
| | Critical thinking | .466 | .067 | .540 | 6.979 | .000 | .268 | 3.725 |
| | mathematical communication | .403 | .067 | .399 | 5.993 | .000 | .363 | 2.754 |
| a. Dependent Variable: Problem Solving | | | | | | | | |

It appears that there is no multicollinearity in this research data (H_0) because the VIF value is less than 10, 3.725 is greater than 10, and 2.754 is less than 10. The tolerance value is greater than 0.10, and the values 0.282, 0.268, and 0.363 are all greater from 0.10. Mathematical literacy (X_1), critical thinking (X_2), and mathematical communication (X_3) are independent variables, meaning they do not interact with each other.

### 4.2 Multiple Linear Regression Analysis

To test this thesis statistically, we used a multiple direct regression model and looked at the significance of the portions. Table 3 displays the findings of assessments of fine knowledge, problem working, critical thinking, and fine communication calculated using SPSS 26.0.

**Table 3** Results of Multiple Regression Measure Calculation

| Coefficients[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardlized Coefficients Beta | t | Sig. |
| | | B | Std. Error | | | |
| 1 | (Constant) | 8.550 | 3.357 | | 2.547 | .013 |
| | Mathematical literacy | .037 | .054 | .052 | .692 | .491 |
| | Critical thinking | .466 | .067 | .540 | 6.979 | .000 |
| | mathematical communication | .403 | .067 | .399 | 5.993 | .000 |
| a. Dependent Variable: Problem Solving | | | | | | |

The multiple direct retrogression model equation can be seen in table 3 as follows $\hat{Y} = 8.550 + 0.037X_1 + 0.466X_2 + 0.403X_3$. Adding scholars' fine knowledge will beget an increase in problem working capacities by 0.037 (Y)(X_1) to 8.550, grounded on this equation with the supposition that critical thinking and fine communication capacities remain constant while scholars' fine knowledge position (X_1) increases by one standard divagation. Critical thinking still maintains fine knowledge and fine communication chops (X_2) at 8.550 with the supposition that X_2 increases by one unit. Likewise, with fine communication chops of 8.550 and an increase in fine knowledge and critical thinking by one unit, there will be an increase in scholars' problem working capacities (Y) of 0.403. In other words, problem working faculty is 3.7 times more likely to be associated with fine knowledge chops, 46.6 times more likely to be associated with critical thinking chops, and 40.3 more likely to be associated with fine communication chops.

## 5 Discussion

The Mathematical Literacy Test, Critical Thinking Ability Test, Mathematical Communication Ability Test, and Student Problem Solving Ability Test were carried out in

three secondary schools in the city of Medan, namely SMPS Bina Tarna Medan, SMPN 20 Medan, and SMPN 32 Medan given to 90 students. Grounded on the exploration results, it was concluded that there was a positive and significant influence between the variables of critical thinking capability, knowledge, spatial capability, and fine communication capability on scholars' contemporaneous problem working capacities.
In line with the findings of this exploration, all scholars need fine chops to face the challenges of the current period of globalization and information [5]. All of these mathematics skills are listed in the KTSP and are also documented in the objectives of basic and secondary mathematics subjects which are enhanced in the 2013 curriculum. Likewise, according to Laia, problem solving skills help students think analytically when making decisions in life. Not only does it help in everyday life, but it also improves other math skills such as basic math knowledge, critical thinking skills, and mathematical communication skills when facing new situations [15].

## 6 Conclusion

Grounded on the results of the exploration data analysis described in the former section, there are several conclusions regarding fine capacities, critical thinking capacities, and fine communication capacities to problem working capacities, including At the same time studying fine thinking chops and fine communication chops related to problem working chops for class scholars VII inferior high academy in Medan. The problem working chops of scholars at SMP VII Medan are partly told by mathematical literacy ability, critical thinking ability, and mathematical communication ability.
The degree of correlation between fine knowledge, critical thinking chops and fine communication chops on the problem working capacities of class VII inferior high academy scholars in Medan is veritably strong, videlicet 0.905 and the measure of determination (R2) is 0.901, indicating that fine knowledge chops, critical thinking chops and fine communication chops make a donation. Amounting to 90.1% of contemporaneous problem working chops. Meanwhile, 9.9% is determined by other variables.

## References


[1] OECD. 2018. *PISA 2015 Result in Focus.* Kanada: OECD. https://www.oecd.org
[2] Johnson. 2014. *Berpikir Kritis "Sebuah Pengantar".* Jakarta: Erlangga.
[3] NCTM. 2000. *Principles and Standards for School Mathematics.* United States of America: The National Council of Teachers of Mathematics, Inc.
[4] Wijayanto, A.D., Fajriah, S.N., & Anita, I.W. 2018. Analisis Kemampuan Komunikasi Matematis Siswa SMP Pada Materi Segitiga Dan Segiempat. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *2*(1), 97–104.
[5] Hendriana, H., Rohaeti, E. E., & Sumarmo, U. 2017. *Hard Skills dan Soft Skills Matematik Siswa*. Bandung: Refika Aditama.
[6] Fauziah, S. 2018. *Perbandingan Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa SMK antara yang Memperoleh Pembelajaran Model Contextual Teaching Learning (CTL) dan Model Problem Based Learning (PBL).* Proposal UNPAS Bandung.

[7] Ulya, R., & Hidayah. I. 2016. Kemampuan Pemecahan Masalah Ditinjau dari Self Efficiency Siswa dalam Model Pembelajaran Missouri Mathematics Project. *Unnes Journal of Mathematics Education Research.* 5(2), 178-183.
[8] Padmadewi, N. N., & Artini, L. P. 2018. *Literasi di sekolah, dari teori ke praktik.* Bandung: Nilacakra.
[9] Kemendikbud. 2022. From reference kemendikbud.go.id
[10] Purwanto, M. N. 1994. *Psikologi Pendidikan.* Bandung: PT. Remaja Rosdakarya
[11] Pratiwi, D. D. 2015. Analisis kemampuan komunikasi matematis dalam pemecahan masalah matematika sesuai dengan gaya kognitif dan gender. Al-Jabar: Jurnal Pendidikan Matematika, 6(2), 131-142.
[12] Nofrianto. 2017. *Komunikasi Pendidikan: Penerapan Teori Dan Konsep Komunikasi Dalam Pembelajaran.* Jakarta: Kencana.
[13] Pramuditya, S. A., Wahyudin, & Nurlaelah, E. (2021). *Kemampuan Komunikasi Digital Matematis*. Bandung: CV. Media Sains Indonesia.
[14] Ritonga, Ester Cronica. 2018. Efektivitas Model Problem Posing terhadap Kemampuan Pemecahan Masalah Matematis Siswa di SMP Negeri Angkola Selatan. *Jurnal Math Edu Institut Pendiddikan Tapanuli Selatan*. 1(2).
[15] Laia, H & Harefa, D. 2021. Hubungan Kemampuan Pemecahan Masalah Matematis dengan Kemampuan Komunikasi Matematik Siswa. *Aksara: Jurnal Ilmu Pendidikan Nonformal*, 7(2), 463-473119.