# 45996 Final

*by* Production Team

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# Analysis of Students' Proficiency in Mathematical Communication Through the View of Self-Regulated Learning


**Abstract**

Changes in the education implementation system during the Covid-19 pandemic force students to adapt quickly. This adaptation occurs because online learning limits teachers ' ability to monitor the overall learning carried out by students. Therefore, in the implementation, students must have Self-Regulated Learning to manage their learning activities independently and analyze their learning needs. In addition, Self-Regulated Learning is also able to provide support for improving various abilities, for example, mathematical communication. This study aimed to determine whether Self-Regulated Learning affects students' mathematical communication skills. The research method used is correlational with a sample of 31 students in grade IX of a junior high school in Serang City. The results of this study indicate that Self-Regulated Learning affects students' mathematical communication skills, with a coefficient of determination equal to 21%. This research can inform educators that Self-Regulated Learning influences students' mathematical communication abilities, so educators must design learning to help improve students' Self-Regulated Learning.



***Keywords**: Self-Regulated Learning; Mathematical Communication; Covid-19; Effect.*



*Abstrak*

*Perubahan sistem pelaksanaan pendidikan pada kondisi pandemi Covid-19 memaksa siswa untuk beradaptasi secara cepat. Adaptasi tersebut terjadi karena pembelajaran secara online memberikan batasan bagi guru untuk memantau keseluruhan pembelajaran yang dilakukan oleh siswa. Oleh karena itu, dalam pelaksanaan pembelajaran secara online siswa harus memiliki Self-Regulated Learning agar mampu mengatur kegiatan belajarnya secara mandiri dan mampu menganalisis kebutuhan belajarnya. Selain memberi dukungan yang besar terhadap pelaksanaan pembelajaran secara online, Self-Regulated Learning juga mampu memberi dukungan terhadap peningkatan berbagai kemampuan, salah satunya adalah komunikasi matematis. Penelitian ini bertujuan untuk mengetahui apakah terdapat pengaruh Self-Regulated Learning terhadap kemampuan komunikasi matematis siswa. Metode korelasional digunakan dengan sampel penelitian sebanyak 31 murid kelas IX di salah satu SMP di Kota Serang. Hasil penelitian ini menunjukkan Self-Regulated Learning berpengaruh terhadap kemampuan komunikasi matematis siswa dengan koefisien determinasi yaitu sebesar 21%. Penelitian ini dapat memberikan informasi kepada pendidik bahwa Self-Regulated Learning berpengaruh terhadap kemampuan komunikasi matematis siswa, sehingga pendidik harus merancang pembelajaran yang dapat membantu meningkatkan Self-Regulated Learning siswa.*


## INTRODUCTION

A disease that attacks the human respiratory system called Covid-19 has been reported in Wuhan, in December 2019 (Ciotti et al., 2020). This disease spread worldwide and affected many countries, so WHO declared Covid-19 as a pandemic in March 2020 (Pokhrel & Chhetri, 2021; Tarkar, 2020)

This disease spreads and is contagious in a short time. On 18 April 2020, WHO reported that more than 2.1 million cases of Covid-19 had been confirmed and caused the death of 142,229 people in 213 countries (WHO, 2020).

Covid-19 has also spread in Indonesia. In March 2020, the President of Indonesia announced the first case of Covid-19 infection, which infected two of his citizens. Every day, the number of residents infected with Covid-19 is increasing, so to suppress the spread of Covid-19, the government in Indonesia is implementing physical distancing, one of which has an impact on closing schools, which means that learning cannot be present in classes to prevent the spread of Covid-19 (Rulandari, 2020).

This rule is included in Circular No. 4 of 2020 on implementing education during the emergency period due to the spread of Covid-19, which stipulates that

the learning process takes place at home through online/ distance learning. Activities and tasks carried out by students may vary, considering conditions, access, facilities, and student learning interests (Ministry of Culture and Education, 2020).

Learning that is carried out online requires students to organize their learning activities because the teacher cannot be physically present to monitor the activities carried out and cannot provide assistance or support directly (Wong et al., 2019). Therefore, students must have good Self-Regulated Learning (SRL) in implementing online learning.

Self-Regulated Learning (SRL) helps students understand their study habits, get used to self-regulation, and manage time in learning activities (Sudinadji & Kumaidi, 2019; Effeney et al., 2013; Zimmerman, 2008). SRL is an attitude within a person to manage their thoughts, behaviours, and emotions in obtaining learning experiences (Zumbrunn et al., 2011). SRL is essential for students because they will be able to control their actions and be able to control the learning activities they carry out to achieve success in the academic field (Effeney et al., 2013).

SRL has a relatively stable tendency to respond to various learning situations (Setyaningrum, 2019). It means that in conditions before the pandemic (offline learning), during the pandemic (online learning), and when the pandemic ends (when learning goes offline again), SRL is an essential thing that students need have. This statement is strengthened by the results of research conducted by Sun, et al. (2018), which shows the importance of SRL in both pre-class Internet-based (online learning) and in-class collaborative learning (offline learning).

In addition to providing outstanding support for implementing online learning, SRL can also support increasing the knowledge competencies students need. The knowledge competencies students need in mathematics lessons are generally included in the mathematics learning objectives presented by the NCTM (2000). The objectives of learning math are to develop the ability to (1) mathematical communication, (2) mathematical problem solving, (3) mathematical connection, (4) mathematical reasoning and proof, and (5) mathematical representation. Based on these learning objectives, mathematical communication is essential to master.

According to Sundayana et al. (2017), mathematical communication is an important ability for students to form concepts, determine strategies, carry out scientific investigations, and a means of communication to obtain and share thoughts and information that can be used as capital for students' success in solving problems. Communication is essential to human life because communication can solve various problems in a person's life, and even communication can improve relationships with other people (Liliweri, 2017).

In the learning process, both offline and online, the teacher must help students develop their communication skills (Rustam & Ramlan, 2017). Baroody (1993) states two important reasons for developing mathematical communication: (1) Mathematics is a language that accurately, clearly, and succinctly communicates ideas. (2) Learning math is a social activity that requires interaction (communication) between teachers and students to develop students' potential in mathematics.

Mathematical Communication Skills (MCS) are a mandatory requirement for students. However, many studies say Indonesian students' mathematical

communication skills still need improvement. Ahmad and Nasution (2018) concluded that 40% of students had low categories in MCS. The same opinion was expressed by Wijayanto et al. (2018) The Mathematical Communication Skills of junior high school students are still in the low category. This can be seen in the results of the questions being tested. Based on the explanation, it is necessary to examine mathematical communication skills based on SRL during the Covid - 19 pandemic.

Cotton (2008) classifies communication into two: oral and written communication. Oral communication occurs when interactions (dialogues) and discussions occur between students or between students and teachers on the topic being studied, which can help deepen student understanding and help students find mistakes in solving math problems. In contrast, communication through writing occurs when students can use notations, pictures, and words to solve mathematical problems.

Mathematical communication skills that will be studied in this study are written communication skills because the results of student work expressed in writing are essential things that can be a source of information for teachers in understanding how students think (Pugalee, 2001). When the results of students' thinking are put into words, the teacher can adjust instructions and provide support and assistance according to student needs (Back et al., 2010).

## METHOD

This research used a nonexperimental research design involving causal relationships that explore cause and effect relationships between variables without using the experimental method (Gall et al., 2010). The research method used in this study is a correlation method with a quantitative approach. This study aimed to examine how SRL affects students' mathematical communication skills.

The population in this research were students in grade IX at one of the junior high schools in Serang City. The sample of this study was 31 students in class IX who carried out online learning for about two years during classes VII and VIII.

The material used in this research was SPLDV, taught in class VIII (when learning was still online). This study used 12 questions from a mathematical communication ability test instrument and a non-test instrument in an SRL scale of 32 statement scales, including 16 positive and 16 negative statement scales. Experts have validated all instruments used.

This research was conducted with several stages, including: 1) Collecting data, at this stage, the researcher distributed questionnaires of Self-Regulated Learning and a mathematical communication test. After the students had completed the questionnaire and mathematical communication test, the researcher collected them. 2) Data Analysis, at this stage, the researcher analyzed maximum, minimum, and average scores. Various tests were also carried out using SPSS, including normality, linearity, regression, and correlation tests. 3) finally, the researcher concluded. The research stages are shown in Figure 1.

The indicators used to measure mathematical communication skills were adopted from the indicators presented by Syafina & Pujiastuti (2020) because the mathematical communication abilities measured in this study were the same as those measured in this study (mathematical communication skills for written tests). The indicators used include: 1) writing what is known and required from

the problems presented; 2) representing ideas and mathematical situations in the form of symbols or mathematical models; 3) writing down the appropriate calculation operations and writing down the solutions to these problems; 4) make conclusions from the solutions obtained. The Self-Regulated Learning indicator used in this study was adopted from the independent learning indicator that Zimmerman (2002) has conveyed by not including the last indicator, having self-efficacy or self-concept, because this indicator is an active variable that can stand alone. Other indicators can be used because they are an integral part of the self-reliance cycle described earlier, namely planning, monitoring, and evaluation. So, the indicators used include 1) diagnosing learning needs; 2) initiative and motivation to learn; 3) viewing a difficulty as a challenge; 4) formulating learning objectives; 5) selecting and implementing the chosen learning strategy; 6) utilizing and searching for relevant sources; 7) organize, control and monitor the learning activities carried out; 8) evaluation of learning processes and outcomes (Zimmerman, 2002).

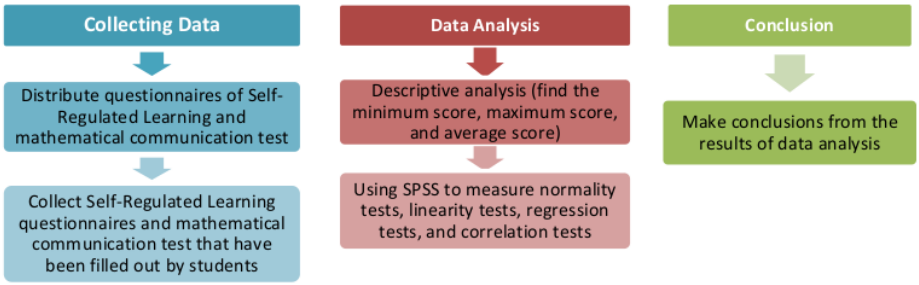


**Figure 1**. Research Stages

## RESULTS AND DISCUSSION

### Results

The data analyzed in this research came from mathematical communication skill tests and SRL questionnaire data. The results of acquiring mathematical communication skills are presented in Figure 2 to make it easier for readers to understand and read research data.

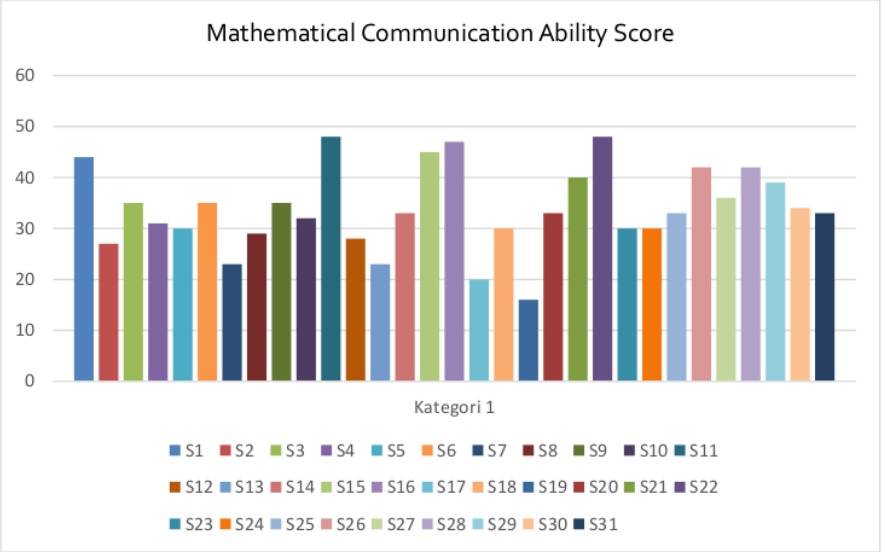


**Figure 2.** Mathematical Communication Ability Test Scores

The student had a maximum score of 48 and a minimum score of 16 on the mathematical communication skills test. The maximum score students obtained if they answered all the questions correctly was 48. The average score was 33.90, so there were 14 students with scores above the average of as many as 31.

To find out students' Self-Regulated Learning, they were given a questionnaire containing 32 statements consisting of 8 indicators, including: 1) diagnosing learning needs; 2) initiative and motivation to learn; 3) viewing a difficulty as a challenge; 4) formulating learning objectives; 5) selecting and implementing the chosen learning strategy; 6) utilizing and searching for relevant sources; 7) organize, control and monitor the learning activities carried out; 8) evaluation of learning processes and outcomes. The results of students' SRL scores are shown in Figure 3.

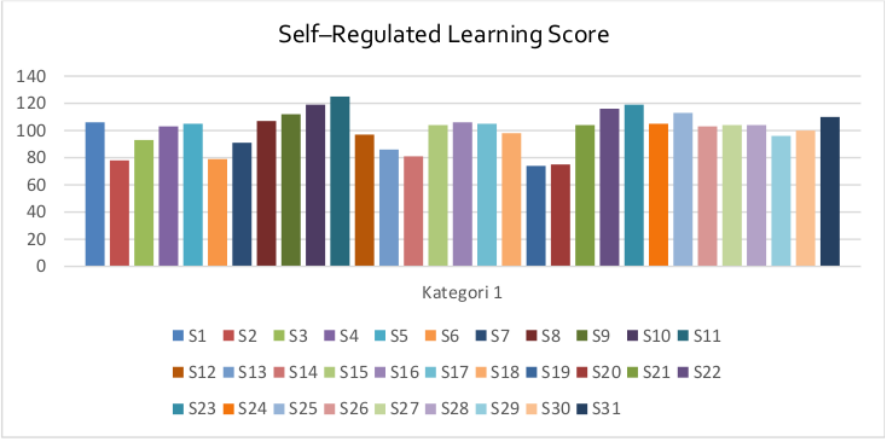

**Figure 3.** Self–Regulated Learning Score

The lowest student score in the self-regulated learning questionnaire data calculation is 67, and the highest is 125. The maximum score students in the self-regulated learning calculation can obtain is 128. The average student score is 100.58, so 19 students have scores above average.

Furthermore, various tests were carried out using SPSS to determine whether or not there was an effect of Self-Regulated Learning on students' mathematical communication abilities. The test performed is a regression test.

However, prerequisite tests, including normality and linearity tests, are run before the regression test. The normality test used Shapiro-Wilk in IBM SPSS statistics 26 with α = 0.05. The test results show a significance value for mathematical communication ability of 0.496 and a significance value for SRL of 0.084. The significance values are greater than 0.05, so we can conclude that the two data are normally distributed. Details of the normality test results are shown in Table 1:

**Table 1.** Normality test results

| | Shapiro – Wilk | | |
|---|---|---|---|
| | Statistic | df | Sig |
| *Self–Regulated Learning* | 0,940 | 31 | 0,084 |
| Mathematical Communication | 0,969 | 31 | 0,496 |

The following prerequisite test is the linearity test. This test determines whether Self-Regulated Learning is linearly related to students' mathematical communication skills using IBM SPSS statistics 26 with α = 0.05. The results of the linearity test are shown in Table 2.

**Table 2.** The results of the data linearity test

| | | | Sum of Squares | df | Mean Square | F | Sig |
|---|---|---|---|---|---|---|---|
| Mathematical Communication * Self–Regulated Learning | Between Groups | (Combined) | 1754,293 | 22 | 79,741 | 3,616 | ,033 |
| | | Linearity | 410,013 | 1 | 410,013 | 18,593 | ,003 |
| | | Deviation from Linearity | 1344,280 | 21 | 64,013 | 2,903 | ,062 |
| | Within Groups | | 176,417 | 8 | 22,052 | | |
| | Total | | 1930,710 | 30 | | | |

Based on the linearity test results in Table 2, we find a significant deviation from linearity of 0.062. Since the sig value is greater than 0.05, we can conclude that there is a linear relationship between SRL and students' mathematical communication skills.

Once the data are found to be normal and linear, we can do a simple linear regression test (see Table 3). The SPSS output results show a calculated F value of 7.819 with a significance level of 0.009. Since this value is less than 0.05, we can conclude that SRL affects students' mathematical communication skills.

The calculated data are used to construct the regression equation shown in Table 4. Based on the calculation, the regression equation is $\hat{Y}=5.729+0.280X$. This can be interpreted that if the student's SRL is worth 0, then the student's mathematical communication ability is worth 5.729. In addition, the coefficient of student Self-Regulated Learning is positive at 0.280, indicating a positive effect between student self-regulated learning and mathematical communication skills. Full calculations are

shown in Table 4.

**Table 3.** Data regression test results

| Model | | Sum of Squares | df | Mean Square | F | Sig |
|---|---|---|---|---|---|---|
| 1 | Regression | 410,013 | 1 | 410,013 | 7,819 | ,009[b] |
| | Residual | 1520,697 | 29 | 52,438 | | |
| | Total | 1930,710 | 30 | | | |

a. Mathematical Communication Dependent Var)
b. Predictors: SRL

**Table 4.** Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients Beta | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | | | |
| 1 | (Constant) | 5,729 | 10,159 | | ,564 | ,577 |
| | Self-Regulated Learning | ,280 | ,100 | ,461 | 2,796 | ,009 |

a. Mathematical Communication (Dependent Var)

Furthermore, a correlation test was also performed to determine the magnitude of the effect of SRL on mathematical communication skills. Based on the tests performed, the magnitude of the correlation/relationship (R) between Self-Regulated Learning and mathematical communication skills equals 0.416. From these results, a coefficient of determination (R square) of 0.212 is obtained, which means that the effect of the SRL on the dependent variable (mathematical communication ability) is 21%. The results of these calculations fall into the interval 0.20 - 0.39 with the low category. In comparison, the remaining 79% of students' mathematical communication skills are influenced by other factors. Complete calculations are shown in Table 5.

**Table 5.** Correlation value test results

| Model | R | R Square | Adjusted R Square | Std. Error of Estimate |
|---|---|---|---|---|
| 1 | ,416[a] | ,212 | ,185 | 7,241 |

a. Predictors, SRL

## Discussion

The calculation results show that SRL affects students' mathematical communication skills. This aligns with the research results revealed by Sulastri and Sofyan (2022) that SRL affects students' mathematical communication skills. So, we must pay attention to the efforts to improve mathematical communication abilities. In line with this opinion, Ilimunthe et al. (2023) stated that students with higher levels of SRL also had better mathematical communication skills. This applies under the best conditions. Students with low SRL also

have low mathematical communication skills. Other research that strengthens the results of this research is also stated by Nurhasanah & Zhanty (2019) that SRL positively affects students' mathematical communication abilities by 57.7%.

To analyze the effect of SRL on mathematical communication skills (shown in the results of student work). Figure 4 and Figure 5 are students' answers to tests of mathematical communication skills on the indicators identifying known elements and the sufficiency of the required elements.

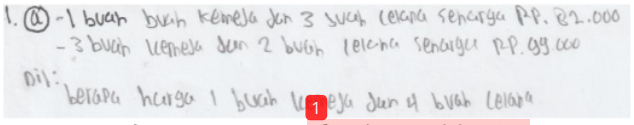

**Figure 4.** Responses of students with low SRL

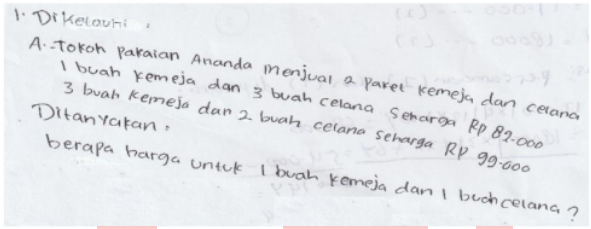


**Figure 5.** Responses of students with high SRL

Figure 4 shows the responses of students with low SRL levels. It can be seen that students have been able to identify a small part of the known and asked elements, but these students still need to identify the elements that are asked correctly. Figure 5 shows students' responses in the high Self-Regulated Learning category. In these answers, students can identify and formulate information related to known things and ask questions correctly from the questions presented.

This result aligns with the opinion of Muharomi and Afriansyah (2022) that students with high SRL can understand questions and write down known and asked information. In line with this, Mayasari and Rosyana (2019) argued that students who had to write down what they knew and ask questions about the problem had low SRL. Furthermore, the answers for indicators of planning strategies to solve problems by making representations or constructing mathematical models of problems are presented in Figure 6 and Figure 7.

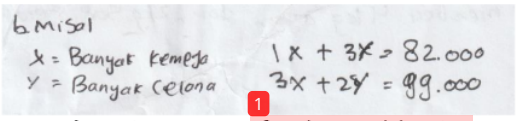


**Figure 6.** Responses of students with low SRL


**Figure 7.** Responses of students with high SRL

Figure 6 shows the responses of low-category Self-Regulated Learning students. It can be seen that students make models not by the questions given. In the first equation, students make mistakes in using variables. The student should have written 3y as a model of 3 pants, but the student had written 3x. The findings in this study are the same as the opinion expressed by Sulistyani et al. (2020) that students with SRL are in a low category, unable to present problems in mathematical models.

While Figure 7 shows the responses of students with high SRL categories, it can be seen that students can make a clear and precise representation or mathematical model of the problem. Students can describe a mathematical situation by changing the existing problems in the problem into a mathematical model. The steps that students take are as follows. First, students make an example of x being the number of shirts and y being the number of pants. Then, students change the problem in a mathematical model, namely x+3y=82,000 and 3x+2y=99,000. Agustiani et al. (2021) stated that students with a high category of SRL could find relationships between variables based on the facts presented in the questions and then create mathematical models based on the information in these questions. Furthermore, the results are presented in Figure 8 and Figure 9 as follows.

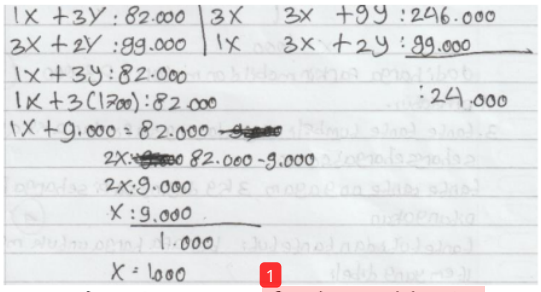


**Figure 8.** Responses of students with low SRL

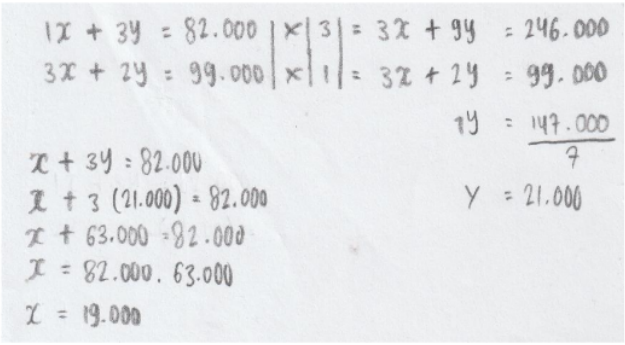


**Figure 9.** Responses of students with high SRL

Figure 8 shows the responses of students with low levels of SRL. It can be seen that students have yet to be able to use the elimination and substitution methods to solve the problems. Figure 9 shows that students with high SRL levels can use the elimination method well. This can be seen from the steps taken, namely,

students eliminating the x variable by multiplying the first equation x+3y=82,000 by the number 3 and multiplying the second equation 3x+2y=99,000 by the number 1 so that the x variable can be eliminated and produces a value of y=21,000. The students also mastered the substitution method very well. This can be seen from the next step in the previous process, where the value y=21,000 is substituted into one of the equations and produces the value x=19,000. The last indicator, namely re-examining the steps taken and writing down the answers or conclusions obtained on the mathematical communication ability test questions, is shown in Figure 10 below.

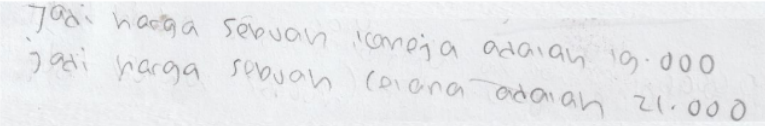


**Figure 10.** Responses of students with high SRL

Figure 10 shows the answers of students with a high SRL category. In these answers, it can be seen that students can write conclusions correctly. This is different from students with low levels of SRL. Students need to provide answers because they cannot write conclusions from the problems given.

Based on the analysis of each indicator, it is known that SRL affects students' mathematical communication. Ekananda et al. (2020) argue that students with high SRL can understand problems, plan to solve problems, link various concepts to solve problems and draw conclusions from the answers. Arum (2017) conveyed a similar opinion that students with high SRL can identify problems and information in the questions, design appropriate strategies accompanied by reasons that support the selection of these answers, and conclude the results.

This research shows that students with high Self-Regulated Learning can carry out learning activities well despite facing different learning conditions. They tend to adapt to new learning conditions (online learning) quickly and do not require close supervision in learning activities because the learning activities they carry out are based on their inner awareness of the need and necessity to learn. Students with high Self-Regulated Learning have high motivation in learning. When they experience difficulties in the learning process, they immediately look for relevant learning resources such as ebooks, which they can download for free on Google or search for information on YouTube. In contrast, children with low Self-Regulated Learning require close assistance in learning activities. When they face difficulties in solving a problem, they tend to give up quickly and do not have to look for other learning sources to support the learning process.

This is in line with the opinion expressed by Pelikan, et al. (2021) that a learning process requires high levels of Self-Regulated Learning for students. Especially when offline learning is switching to online learning during the Covid-19 pandemic, students with high Self-Regulated Learning can set learning objectives, manage time, and use various strategies that are considered effective in supporting learning activities. Furthermore, they can continue to increase their learning motivation until they obtain assessment results that they feel are high.

Based on this, we can conclude that Self-Regulated Learning is an essential thing that students need to have. So, in any learning situation, whether online or offline, students can learn well without experiencing obstacles.

**Implication of Research**

The results of this study should inform educators that Self-Regulated Learning influences students' mathematical communication abilities. So, apart from completing learning materials, educators must design learning that can help improve students' SRL. This study is also intended to serve as a reference for researchers wishing to conduct similar research, particularly regarding the impact of SRL on various students' mathematical abilities.

**Limitation**

Limitations in the research, the number of students included in this study was limited and only focused on one school. This allows the results to be different in other schools with different accreditation and input standards for student admissions. However, the results of this study can be used as evidence that SRL influences students' mathematical communication skills. Furthermore, the impact of SRL on mathematical communication skills is 21%. At the same time, the remaining 79% of students' mathematical communication skills are affected by other factors. So, it requires further research to analyze other factors affecting students' mathematical communication abilities.

**CONCLUSION**

Online learning causes various changes, one of which is that students should be independent in their learning activities. SRL is believed to be related to improving mathematics abilities, especially mathematical communication. This is clearly shown by the linearity test results, which show a sig deviation from the linearity value of 0.062. From this, we can conclude a linear relationship between SRL and students' mathematical communication skills. A simple linear regression test with a sig level of 0.009 confirms these results. This value is less than 0.05. We can conclude that SRL affects students' mathematical communication skills. The magnitude of the influence of the independent variable (SRL) on the dependent variable (mathematical communication ability) is 21%. At the same time, the remaining 79% of students' mathematical communication skills are influenced by other factors.

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