Journal of Educational Research and Evaluation
Volume 6, Issue 3, 2022, pp. 645-652
P-ISSN: 2597-422x E-ISSN: 2549-2675
Open Access: https://doi.org/10.23887/jere.v6i4.47593

The Relation between Self-Regulated Learning and Mathematical Problem-Solving During Covid-19

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ARTICLE INFO

Article history:
Received June 02, 2022
Revised June 05, 2022
Accepted September 24, 2022
Available online November 25, 2022

Kata Kunci :
Kemandirian Belajar, Pemecahan Masalah Matematis, Covid-19

Keywords:
Self-Regulated Learning, Mathematical Problem Solving, Covid-19

ABSTRAK

Perubahan proses pembelajaran yang kerap kali terjadi pada masa covid-19 mengindikasikan siswa perlu mengembangkan kemampuan mengatur, mengarahkan, menyesuaikan dan mengendalikan diri. Self-regulated learning merupakan salah satu aspek yang diperlukan pada pembelajaran masa Covid-19 karena Self-Regulated Learning memberikan pengaruh terhadap pemecahan masalah matematis. Penelitian ini merupakan penelitian korelasional yang bertujuan untuk menganalisis relasi antara Self-Regulated Learning dengan pemecahan masalah matematis pada masa covid-19. Sebanyak 350 siswa kelas XI dari empat SMA Negeri yang dipilih dengan teknik simple random sampling menjadi sampel penelitian. Data dikumpulkan melalui kuesioner self-regulated learning dan tes kemampuan pemecahan masalah. Data yang telah diperoleh dianalisis menggunakan Winsteps dan SPSS. Uji korelasi Pearson dan uji koefisien determinasi dilakukan untuk melihat korelasi antara dua variabel. Hasil riset menunjukkan bahwa terdapat relasi antara Self-Regulated Learning dengan pemecahan masalah matematis di masa covid-19 dengan korelasi Pearson sebesar 0,634. Melalui hasil riset dapat diketahui bahwa tingkat abilitas siswa dalam menyelesaikan masalah matematis meningkat seiring dengan peningkatan self regulated learning mereka. Sehingga riset ini dapat memacu siswa meningkatkan self-regulated learning untuk membantu mereka dalam menyelesaikan permasalahan matematika.

ABSTRACT

Changes in the learning process that often occur during the Covid-19 period indicate that students need to develop the ability to organize, direct, adjust and control themselves. Self-regulated learning is one of the aspects required in learning during the Covid-19 because *Self-Regulated Learning* influences mathematical problem-solving abilities. This study is a correlation study which aims to analyze the relation between *Self-Regulated Learning* and math problem-solving during Covid-19. The sample for this study was drawn from 350 students in grade XI from four public high schools, who were obtained by simple random sampling. Data were collected through *Self-Regulated Learning* questionnaires and problem-solving ability tests. The data were analyzed using Winsteps and SPSS. Pearson correlation and coefficient of determination tests were conducted to see the relation between the two variables. According to the research conducted, the Pearson correlation coefficient was 0.634, indicating a relation between *Self-Regulated Learning* and students' math problem-solving during Covid-19. Through the results, it can be seen that the level of students' mathematical problem-solving increases along with the increase in their *Self-Regulated Learning*. So, this research can encourage students to improve SRL to help them in solving math problems.

1. INTRODUCTION

Self-regulated learning (SRL) is one of the essential factors supporting success in learning mathematics during Covid-19 (Lim et al., 2020; van Alten et al., 2020). SRL is a process where students can organize and discipline themselves to develop their learning skills by involving specific thoughts, behaviors, and strategies to achieve these goals (Cleary & Kitsantas, 2017; Gestiardi & Maryani, 2020). SRL as the ability of students to regulate themselves to be actively involved in the learning process both metacognitively, motivationally and behaviourally. Students as independent learners can make plans, set goals, organize, monitor, and evaluate themselves in the metacognitive process (Gestiardi & Maryani, 2020; van Alten et al., 2020). The motivational process is related to self-efficacy, attribution, and task interest. While in the behavioural process, students independently choose, organize, and create a learning environment that can optimize their learning process (Zimmerman, 1990). SRL gives students the skills to make the learning process much easier and have a solid drive to learn by planning, monitoring, and evaluating the learning process independently to get good results (Fauzi & Widjajanti, 2018; Magno, 2010). That way, SRL will help students become responsible individuals, believe in their abilities, and be

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able to overcome difficulties (Anjarsari et al., 2021; Lidiawati & Helsa, 2021). In other words, SRL greatly affects students' ability to solve problems (Ansori & Herdiman, 2019). SRL as a student's effort in learning activities that can be done by students themselves or with the help of others based on their motivation to understand the subject matter so that it can be used to solve problems. This statement means that with SRL in students, students can assess themselves, set goals, and increase their confidence and enthusiasm for learning based on their ability to solve problems at hand, which will impact their mathematical problem-solving skills. Problem-solving ability is one of the essential abilities that students must possess and must be mastered in learning mathematics (Putra et al., 2018; Valtonen et al., 2017). Problem-solving is a medium for students to develop their thinking skills (Ahmad & Asmaidah, 2017; Amalia et al., 2017). When students solve problems, they must know what steps or strategies they should apply and how to use them (Gog et al., 2020). Problem-solving is an activation process that emphasizes applying structured methods, procedures, and strategies (Nurfitri & Jusra, 2021). So that students understand that the essential thing in solving problems is not just getting a solution, but there is a process that they must do first. In addition, problem-solving skills also have an essential role in making decisions or solving problems that arise due to changes and developments in science and technology based on the four stages of Polya's problem-solving (Chabibah et al., 2019). However, the reality is that not all students in Indonesia can solve math problems related to everyday problems. It is because students are unfamiliar with problem-solving-type questions requiring higher-order thinking skills (Nuryana & Rosyana, 2019). Then, problem-solving-type questions are usually presented as non-routine questions (Rianti, 2018). Lack of students' accuracy and expertise is also another cause of low mathematical problem-solving abilities (Putra et al., 2018).

Several studies on SRL and problem-solving abilities have been carried out. When students engage in high levels of SRL, students' mathematical reflective thinking skills in learning improve during Covid-19 (Kamalia & Nuriadin, 2021). Students with high and moderate SRL scored 8.66 on the matematical reflective thinking ability test. The subjects in this study were students who attended religious-based schools. They said that learning during the Covid-19 period could increase their math scores. It is because when the learning process turns into online learning, they can more easily explore learning materials and have more time to study. Meanwhile, they cannot do this during face-to-face learning because of the many religious activities they have to do. Students with high resilience can solve problems better than moderate ones (Rahmatiya & Miatun, 2020). Students with a high level of resilience tend to be more confident when faced with various problems. Meanwhile, students with moderate resilience still lack mathematical problem-solving abilities because they cannot achieve systematic steps in solving mathematical problems, lack accuracy, and tend to give up when faced with difficult questions. Problem-solving skills before and after distance learning were similar, and students already had SRL during the covid-19 period (Harisuddin, 2021). It proves that learning during the Covid-19 period can increase students' SRL. Some of these studies were carried out during the Covid-19 period, and some were not. The subjects used in this research were students at the junior high school level. Data processing in this study did not use the Rasch model. If you look at previous research, there is a gap that no one has discussed about the link between SRL and problem-solving during the Covid-19 period. Thus, this study aims to determine the relationship between SRL and students' mathematical problem-solving abilities during Covid-19.

2. METHODS

This study uses a quantitative approach with correlational research. This research aims to specify the relation between SRL and mathematical problem-solving skills during Covid-19. A total of 350 high school students in class XI from four public high schools in East Jakarta became research samples using a simple random sampling technique. Data collection of student self-regulated learning using a questionnaire. The SRL questionnaire used was adapted from the questionnaire (Magno, 2010). The instrument measures SRL based on three aspects, namely personal, behavioral, and environmental. Seven parameters are measured, namely (1) goal setting and planning; (2) rehearsing and memorizing; (3) self-evaluation; (4) seeking information; (5) keeping records and self-monitoring; (6) environmental structuring; and (7) seeking social assistance (Zimmerman & Pons, 1986). So, the SRL questionnaire consists of 32 statements, 17 positive statements, and 15 negative statements. Four choices of Likert scale answers in the form of strongly agree (SS), agree (S), disagree (TS), and strongly disagree (STS) was used to answer the SRL questionnaire. Meanwhile, the problem-solving ability instrument consists of eight questions related to the derivatives of algebraic function. The instrument is arranged based on the problem-solving steps, namely (1) understand the problem; (2) plan a solution; (3) carry out the plan; and (4) look back (Polya, 1945).

The data that has been obtained will be analyzed using descriptive analysis with the Rasch model assisted by Winsteps and inferential analysis aided by SPSS (Tayibu & Faizah, 2021). The Rasch model is a measurement model that converts raw data in ordinal data into ratio data by using the probability function to produce logit values. The stages of data analysis carried out were instrument analysis, Wright map analysis of self-regulated learning, and Wright map analysis of mathematical problem-solving abilities. Instrument analysis was conducted to see how well the instruments used in this study were. The criteria used to determine the validity of the instrument are the MNSQ outfit value (0.5 <outfit mean square <1.5); outfit ZSTD (-2.0<outfit z-standard<+2.0); and Pt Mea-Corr (0.4 <Pt Mea-Corr < 0.85) (Sumintono & Widhiarso, 2015).

Meanwhile, to see the reliability of items using Cronbach's alpha, item reliability, and person reliability (Bond & Fox, 2015). Those three criteria can also be used to obtain items and persons that fit the Rasch modeling. Items and persons are said to be fit if they meet at least one of the three criteria (Sumintono & Widhiarso, 2015). After getting items and persons that fit the Rasch model, the respondent's ability and difficulty level were mapped based on the measure value using Wright's map. After the data has been analyzed, the next step is the Pearson correlation test to see how the relationship is formed between SRL and students' mathematical problem-solving skills. The coefficient of determination test will also be carried out to see how much SRL contributes to students' problem-solving ability.

3. RESULT AND DISCUSSION

Results

The analysis of the SRL instrument using the Winsteps software show that three items are invalid or not by the required fit criteria, and 148 respondents do not meet the criteria. Meanwhile, one invalid item was obtained with 216 invalid respondents for the problem-solving instrument. Based on the Rasch analysis assisted by Winsteps software, Table 1 shows the reliability measurement on the respondent's side, the items, and the interaction of both. The SRL instrument obtained person reliability and item reliability of 0.84 and 0.99. It means that the consistency of respondents' answers is good, and the quality of the statement items is very nice or qualified. The interaction between respondents and items as a whole is also classified as excellent, which is stated in Cronbach's alpha value of 0.86. Meanwhile, the problem-solving ability instrument has person reliability, item reliability, and Cronbach's alpha of 0.78; 0.99; and 0.78. It shows that the consistency of the respondents in answering the questions is quite good, and the quality of the items is also excellent. The interactions that occur between respondents and items are overall quite good.

Table 1. Summary Statistics of SRL and Mathematical Problem-Solving

Variable	Statistics	Mean	Reliability	Cronbach's Alpha
SRL	Person	0.63	0.84	0.86
	Item	0.00	0.99	
Mathematical Problem-Solving	Person	0.04	0.78	0.78
	Item	0.00	0.99	

The distribution of respondents' abilities and the difficulty level of the statement items in Rasch modeling is based on the Wright map presented in Figure 1. Wright's map offers a logit value range from 4 to -2, with the left side showing the distribution of respondents' abilities which explains the student's SRL position. The higher the student's rank, the higher their SRL level and vice versa. Meanwhile, the right side displays the distribution of statement items that explain each item's difficulty level. The higher the item's rank, the more difficult the item is to be approved. Thirty-three students have high SRL, but there is one student who is at the top rank. Students with the code (141) reacted positively and easily agreed on all items compared to other students. Meanwhile, as many as 32 students still have low SRL. One of them is a student with a code (233) who reacts negatively and has difficulty agreeing to each item of the statement.

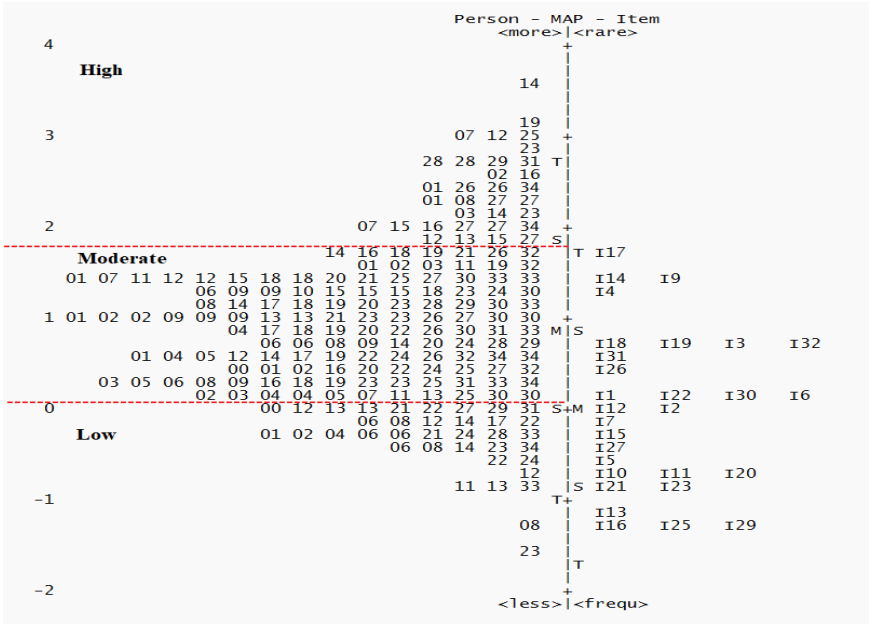

Figure 1. Wright Map of SRL

Figure 2, a map of Wright's mathematical problem-solving ability, shows that as many as 21 students have mathematical problem-solving skills in the high category. Two of them occupy the top position. Students 232 and 258 tend to answer all the questions correctly compared to other students. Meanwhile, seven students still have low mathematical problem-solving abilities. The seven students, 006, 317, 019, 162, 342, 063, and 254, still had difficulty answering each item.

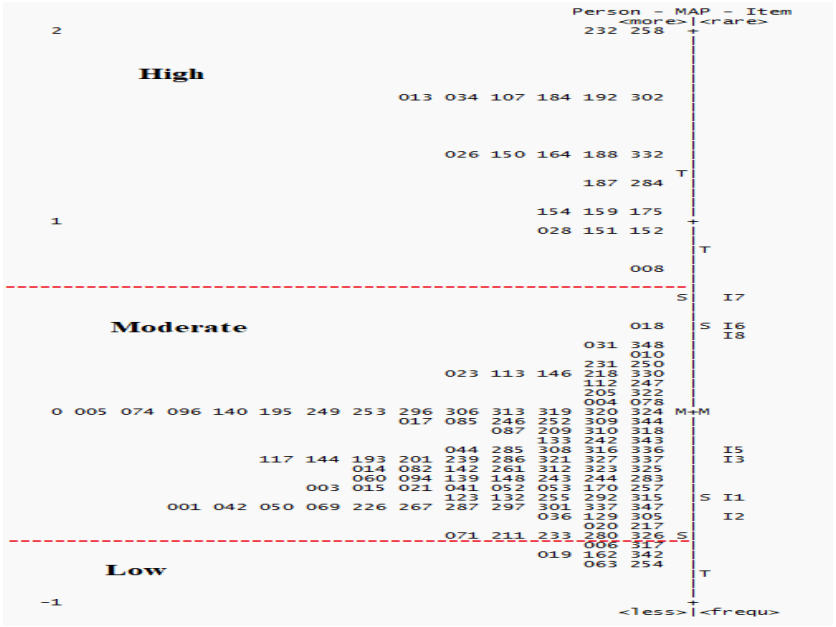

Figure 2. Wright Map of Mathematical Problem-Solving

The Pearson correlation test uses the person-measure value of each variable. One of the conditions for testing the Pearson correlation is that the data tested has the same amount because each respondent of the two variables is measured against each other (Schober et al., 2018). Of 202 and 134 valid respondents, a total of 77 respondents who answered SRL and mathematical problem-solving items were selected for the correlation test. The calculation obtained a p-value of 0.00 ($p < 0.05$). Based on decision-making, it can be inferred that there is a correlation between SRL and students' mathematical problem-solving abilities. The Pearson Correlation coefficient obtained is 0.634, indicating that the level of

relationship between the two variables is high. Furthermore, the coefficient of determination test was carried out to determine how much contribution the SRL had given to the problem-solving ability, and it was obtained at 0.401. SRL contributes to problem-solving skills as much as 40.1% of the contribution. Meanwhile, the other 59.9% was influenced by other factors.

Discussion

Rasch analysis in this study can make it easier for researchers to identify each respondent's ability to answer each question correctly (Hamdu et al., 2020; Herwin et al., 2019). It is because the concept of analysis with the Rasch model is to analyze the overall performance of respondents in answering each question item from the given instrument. The analysis using the Rasch model produces information about the characteristics of the statement items, respondents' answers, and the relationship between the two. The Rasch model is used to analyze items and respondents and to determine the instrument's validity and reliability (Alyani & Zahra, 2020; Bond & Fox, 2015). Three criteria that can be used to assess instrument items fit or misfit are MNSQ outfit, ZSTD outfit, and Ptmea-Corr (Sumintono & Widhiarso, 2015). Meanwhile, to see the reliability of the item using Cronbach's alpha and item and person reliability.

One of the results of the analysis presented by the Rasch model is a map of the distribution of student abilities and statement items called the Wright Map. The Wright map presents the distribution of students' abilities in answering SRL items, followed by a logit scale that shows the student's position. It is known that the learning process during the Covid-19 period often changes according to situations and conditions. The changes in the learning process make students need to adapt to these changes. They must have self-regulation, arrange study schedules, establish a conducive learning environment, manage learning resources, set learning targets, develop self-potential to achieve the target, and evaluate strategies. It follows the results of the Wright map shown in Figure 1. Most students agree on item 1 (I1) related to determining learning targets with the statement, "I set short-term (daily) and long-term (semester) math learning targets." Setting targets or goals can increase student motivation (van Houten-Schat et al., 2018). It is because students focus their attention on something they must achieve and encourage themselves to make plans to obtain the expected results. Making a plan requires an efficient strategy while considering students' knowledge and ability to process methods and the availability of learning resources and contributions from peers, teachers, or others. In addition to item 1, items 16, 25, and 29 were also easily approved by almost all students. Item 16 related to seeking information. It shows that in the learning process during Covid-19, students try to understand material not only from books or teaching materials used by teachers but also from various sources such as Google, YouTube, or online learning applications. Thus, students can gain experience and new knowledge in the learning process (Mustajab et al., 2020; Oinas et al., 2022). Then, on item 25, students readily agreed with the statement, "before studying, I arranged the study area so that it felt comfortable." It means that during the change in the learning process from face-to-face to online, students can arrange their learning environment as comfortably as possible to stay focused on participating in learning activities. A conducive and comfortable learning environment can positively influence learning outcomes (Luo et al., 2021; Ningsih et al., 2019). Furthermore, on item 29, students also readily agreed with the statement, "when I don't understand the subject matter, I will discuss it with my friends." It means that when students have difficulty understanding the subject matter while learning during the Covid-19 period, they dare to ask questions or ask their friends to help explain the material they do not understand. Assistance provided by peers, such as being partners in asking questions, discussing and sharing tasks in assisting them to learn, can contribute to developing student self-regulated learning (Lim et al., 2020; Raaper & Brown, 2020).

The difference in students' mathematical problem-solving ability levels shows that each student has a different perspective on each question item. Each question item can be a problem for some students, but it can also not be a problem for other students, as shown in Figure 2. A total of seven students are in the lowest position. It indicates that the seven students still have difficulty answering the type of problem-solving questions. It is in line with research which states that problem-solving questions are included in the category of non-routine kind of questions (Rianti, 2018; Sari et al., 2018). Often, students find it challenging to solve this type of problem because it requires a complicated process. The lack of giving non-routine questions is one of the causes of the lack of students' mathematical problem-solving abilities (Hadi, 2019; Widodo & Kartikasari, 2017). In general, problem-solving-type problems are contextual or based on real life. However, if students are not trained in solving these questions, they will still experience difficulties. The results of the Pearson correlation test show a significant correlation between SRL and mathematical problem-solving during Covid-19. This result is consistent with research which shows that students with high SRL intensity have good mathematical problem-solving skills (Sulistyani et al., 2020). Students with high SRL tend to be actively involved in the learning process. It is in line with what the

Wright map shows in Figure 1 and Figure 2, which presents that the SRL and mathematical problem-solving logit value are directly proportional. It means that if the student's SRL is high, the student's ability to solve problems is also high. With the changes in the learning process during the Covid-19 period, students need to adjust to these changes by self-regulating and managing their learning activities independently. Previous research proved this statement with the results of its study, which stated that the research subjects had good self-regulation during learning during the Covid-19 period so that they could quickly adapt to changes in the learning process that occurred (Gestiardi & Maryani, 2020; Siregar & Siregar, 2021). The more students can regulate themselves in the learning process, the more they have an interest and willingness to actively participate in the learning process in class (Lidiawati & Helsa, 2021). Students who can regulate themselves towards learning get better achievements than students who cannot regulate themselves (Lidiawati, 2020; Sobri et al., 2020).

The correlation coefficient obtained is 0.634, with a determination coefficient of 40.1%. The results interpreted that the relationship between SRL and problem-solving is strong based on the correlation level parameter (Rusman, 2015). In addition, SRL also provides a significant contribution of 40.1% to students' ability to solve problems. However, this contradicts the research results which states that SRL does not affect one of the mathematical abilities, namely students' mathematical communication skills (Meri et al., 2022). Even so, SRL has been proven to affect student learning outcomes. Based on the study results, the Covid-19 pandemic does not always have a negative impact on life but also has a positive effect, especially on students (Arsyad et al., 2022; Granberg et al., 2021). The change in learning from face-to-face to online and vice versa forces students to study independently, dig up information from various learning sources alone and not depend on the teacher to train their cognitive abilities in learning mathematics. Therefore, learning during Covid-19 increases students' SRL and mathematical problem-solving skills.

4. CONCLUSION

This study reveals a relationship between SRL and mathematical problem-solving during the Covid-19 period. It means that Covid-19 does not always have a bad impact, but there is a good impact on students. Through the results of this study, it can be seen that the level of students' mathematical problem-solving abilities increases along with the increase in their SRL. So, this research can be used for educators become more familiar with the affective aspects of SRL and mathematical problem-solving skills, and students to improve their SRL to help them in solving math problems. SRL has been proven to be an essential factor contributing to mathematical problem-solving skills. It is hoped that future researchers must conduct further and in-depth research to explore information or data regarding the level of SRL during Covid-19 against other mathematical abilities.

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