Jurnal Elemen, 8(2), 645-658, July 2022
https:/doi.org/10.29408/jel.v8i2.5708

e- ISSN: 2442 - 4226

Self-regulated learning and problem-solving ability of elementary school students in fraction during online learning

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Abstract

Online learning for students requires high self-regulated learning to maximize problem-solving skills, especially in fractional material. However, elementary school students have not widely seen self-regulated learning and problem-solving abilities. Therefore, this study aimed to determine the relationship between self-regulated learning and problem-solving skills, especially on fractions in online learning in fifth-grade elementary school. This research is included in a quantitative study that uses a sample of fifth-grade students in an elementary school in Depok City. A sample of 122 students (N = 67 female, N = 55 male) was obtained using a non-probability sampling technique. Data collection techniques were carried out through the distribution of a self-regulated learning questionnaire with as many as 29 statements and a problem-solving ability test instrument with as many as eight questions. The data obtained were measured and analyzed using Rasch modeling and assisted by Winsteps software version 4.4.2. Furthermore, the correlation and Effect Size tests were carried out to determine the relationship and influence between variables. The results showed a significant and interrelated relationship between self-regulated learning and problem-solving ability. In other words, the higher the quality of independence in students, the higher the quality of problem-solving abilities they have, and vice versa. That way, it can encourage students to maximize self-regulated learning when learning online to help improve problem-solving skills in learning.

Keywords: fractions; online learning; problem-solving ability; self-regulated learning

Received: 22 May 2022 | Revised: 6 June 2022
Accepted: 16 June 2022 | Published: 1 July 2022

Introduction

Indonesia has been one of the countries hit by the COVID-19 pandemic for more than 12 months. The COVID-19 pandemic has changed Indonesia's education learning system from offline to online. Online learning can be interpreted as a means to obtain a teaching and learning process that prioritizes innovative and flexible student activities, and it is because online learning can carry out learning activities from anywhere and anytime (Dhawan, 2020). Online learning requires a high degree of independence when studying because the independence carried out while studying has a positive effect on students' ability to carry out learning (Syelitiar & Putra, 2021). In addition, online learning is expected to focus more on the independence of students' learning in receiving, processing, and implementing the explanations received (Kusumaningrum et al., 2020). Self-regulated learning is a student's ability to carry out learning activities independently. In other words, it is part of one of the efforts and abilities that students need to have to carry out learning activities, so they try to be independent in seeking explanations and become motivated to understand learning material without coercion from any party (Nuritha & Tsurayya, 2021).

Self-regulated learning greatly affects the ability of students to solve problems (Safitri, 2018). It happens because it can improve habits and behavior while studying, which is the hallmark of self-regulated learning (Sulistyani et al., 2020). The problem-solving ability has the meaning of a skill that encourages students to take the initiative in systematic thinking when solving problems that are being experienced and to train to recognize problems which can later be implemented in solving complex everyday problems using problem-solving indicators from Polya (Nurdalilah et al., 2013; Ramadhani, 2018). Elementary school students get more than one lesson and one learning process that gets special attention about the ability to solve problems, namely the process of learning mathematics (Yandhari et al., 2019). That way, elementary school students must be able to master the ability to solve problems after going through the math learning process (Mulyati, 2016). In addition to problem-solving abilities, self-regulated learning is also a demand for students when carrying out mathematics learning (Nurhayati, 2017).

From the point of view of mathematics, fractions are one part of mathematics that is a complex topic to teach to elementary school students (Tanjung & Nababan, 2016). *Fractions material* is defined as a field of mathematics that has a relationship with other materials and is very close in everyday life (Malikha & Amir, 2018). Many students find it difficult when do fractional arithmetic operations, and it can be seen in the research results of Arry Safitri et al. (2018), which show that students who are the sample get an average score in the very low category, namely 43.86% which means that students have difficulty. Elementary school students have studied this fraction material since grade III, but students still find it difficult in the learning process because they do not understand the concept of fraction material (Indriani, 2018). Understanding the concept of fractions is difficult for students regarding connecting shapes and understanding; what is meant by this form is (symbols, numbers, and algorithms) while this understanding is the ability to connect mathematical material in real life (Agrawal & Morin, 2016). Students who have difficulty understanding fractions material and adults do not

understand it, so they often fail to process it correctly (Ninaus et al., 2016). It shows that it is essential to study fractions for students (Yang, 2018).

Sulistyani et al. (2020) conclude that the ability to solve mathematical problems is in the high category and comes from high self-regulated learning. On the other hand, students who can solve problems in mathematics are in a low category due to low self-regulated learning. In addition, Ilham Kristanto et al. (2020), examining the relationship of self-regulated learning with the results obtained in learning mathematics in class V Elementary School, obtained a correlation coefficient of 0.478 at the level of the medium relationship. The research described above-conducted data collection before the COVID-19 pandemic, while this study conducted data collection during the COVID-19 pandemic. In addition, the research above has not used Rasch modeling to perform data processing, while this study uses Rasch modeling, which will later get the logit value. With the various circumstances that have been described, this study aims to find out whether or not there is a relationship between self-regulated learning and the ability to solve problems with fractions in online learning in elementary schools.

Methods

The type of research is carried out using the type of quantitative research. This study also aims to discover the relationship between self-regulated learning and students' problem-solving abilities, especially in fractional material in an online learning situation in class V, one of the state elementary schools in Depok City. The population was 857, taken from students in grades I-VI at an elementary school in Depok, West Java, Indonesia. The non-probability sampling technique was chosen as the sampling technique in the study so that a sample of 122 students with 67 female and 55 male students came from all fifth graders in a state elementary school in Depok, West Java, Indonesia.

The instrument used in this study was a self-regulated learning questionnaire and a test of problem-solving abilities. The self-regulated learning questionnaire instrument and indicators are adapted from Ristatiwi (2017), Sa'diyah (2017), Suleang et al. (2021), and Yuna (2021). So there are 29 statements, consisting of 15 statements that show a positive attitude and 14 statements that show a negative attitude. For answering the questions, alternative answers are provided that are based on a Likert scale, such as SL (Always), SR (Often), KD (Sometimes), and TP (Never) (Muhammad, 2020). The indicators of the self-regulated learning questionnaire are presented in the following table 1 below.

Table 1. Self-regulated learning indicators

Self-Regulated Learning Indicator	Statement
Responsibility	Completing assignments from the teacher Doing homework
Inisiative	Learn whithout being ordered
Self confident	Do not have dependence on other during the learning process Believe in your own abilities
Velue time	Using free time to study
Independent	Doing assignments from the teacher without the help of other

The test instrument on ability in problem-solving consists of questions on the subject of fractional material, namely calculating addition, subtraction, multiplication, division, mixed operations, and comparisons adapted from test questions (Purnomosidi et al., 2018). So the question consists of 8 questions. According to Polya (Widyastuti, 2015), the types of instruments in this study were arranged using the steps in the problem-solving indicators, which can be seen in Table 2 below.

Table 2. Indicator of problem-solving ability

Indicator	Indicator	Definition of Indicator
1	Understanding the problem	The ability to use questions to make decisions about what is known and needed.
2	Divising a plan	The ability to use all the information contained in the question to create a plan or procedure to resolve the issue raised.
3	Carrying out the plan	The ability to solve existing questions and answer them accurately according to the steps taken from the beginning.
4	Looking back	The ability to validate the answers received by using methods or procedures that are accurate and believe the truth of the answers given.

Testing the validity and reliability of the questionnaire instrument for self-regulated learning and the test instrument for problem-solving ability using Rasch Modeling assisted by Winstepss software version 4.4.2. Aspects of validity using Rasch modeling using criteria such as the outfit mean square value received ($0.5 <$ Outfit – mean square < 1.5), the outfit z-standard value received ($-2.0 <$ z-standard $< +2.0$), and the received Point Measure Correlation value ($0.4 <$ Point Measure Corr < 0.85) (Sumintono & Widhiarso, 2015). Meanwhile, Sumintono and Widhiarso (2015) suggest that to see the categories in deciding the value of item reliability and person reliability, use the following criteria (See Table 3).

Table 3. Reliability criteria in Rasch modeling

Reliability Value (Person/Item)	Interpretation
> 0.94	Spesial
0.91 – 0.94	Very good
0.81 – 0.90	Very nice
0.67 – 0.80	Enough
< 0.67	Weak

Before conducting further research, Rasch modeling can also see the level of difficulty of each item by looking at the measure value and using category standards. For the very difficult category to get a logit value greater than +1SD, then for the difficult category to get a logit value ranging from 0.0 to +1SD, and for the easy category to get a logit value ranging from 0.0 to -1SD, while for the very easy category, the logit value is less. from -1SD (Sumintono & Widhiarso, 2015).

Furthermore, to see the relationship between self-regulated learning and the problem-solving abilities of fifth grade elementary school students, a correlation analysis was carried out which required testing the product moment correlation with the Pearson formula (Tnius, 2018).

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}} \quad (1)$$

To show the measurement of the strength of the relationship and the strength of the influence between the two variables, namely the self-regulated learning variable and the problem-solving ability variable, then the Effect Size measurement is used with the criterion value of $d < 0.2$ then it is in the small category, if $0.2 < d < 0.8$ then it is in the medium category, and the value of $d > 0.8$ then it is in the high category (Saregar et al., 2016).

Results

Analysis of instruments

The validity test on the self-regulated learning questionnaire instrument using the Winsteps software version 4.4.2 showed that there were six invalid items and 36 respondents who were not valid. Meanwhile, in the test instrument for problem-solving ability to get results, there are 1 item invalid item and 68 respondents invalid person.

Judging from the analysis results using Winsteps software version 4.4.2 in Table 4, the reliability test on person reliability, item reliability, and Cronbach's Alpha formula on the self-regulated learning questionnaire instrument got 0.81; 0.96; 0.90. It can be concluded that the consistency of students in answering the questionnaire statements is included in the very nice criteria. However, the quality of the items in the questionnaire is included in the particular criteria. In addition, the relationship between the item and the person is included in the very nice category.

Table 4. Summaries of statistics questionnaire

	Mean	***SD***	***Reliability***	***Cronbach***
Person	2.21	1.37	0.81	0.90
Item	0.00	1.05	0.96	

Meanwhile, from Table 5, it can be seen that the reliability test on the problem-solving ability test instrument got the results of person reliability, item reliability, and Cronbach's Alpha formula, respectively 0.84; 0.97; 0.81. It can be concluded that the quality of the person on the test questions shows the quality of entering the criteria is very nice. In contrast, the quality of the items on the test questions shows the quality of entering the particular criteria. The relationship between the person answering the items entering the criteria is very nice.

Table 5. Summaries of statistics test question

	Mean	***SD***	***Reliability***	***Cronbach***
Person	-0.24	0.65	0.84	0.81
Item	0.00	0.49	0.97	

Self-regulated learning variable

Based on Figure 1, there is a Wright Map derived from the Winsteps software version 4.4.2, which analyzes self-regulated learning instruments with logit lengths ranging from 5 to -2. In addition, there is also a person map on the left and an item map on the right which describes the person's level of ability and the item's difficulty level. The person's ability level on the self-regulated learning instrument, six students rank at the top, with numbers (034, 097, 103, 109, 110, and 117). It shows that students occupy the quality with high ability and can answer questions easily compared to other students. Meanwhile, there is one student who ranks at the bottom with a number (061) so that it, which shows the ability to answer questions that the student has in a low category and shows that the student has difficulty answering questions except for the questions on the label (I16, I2, I25, I6).

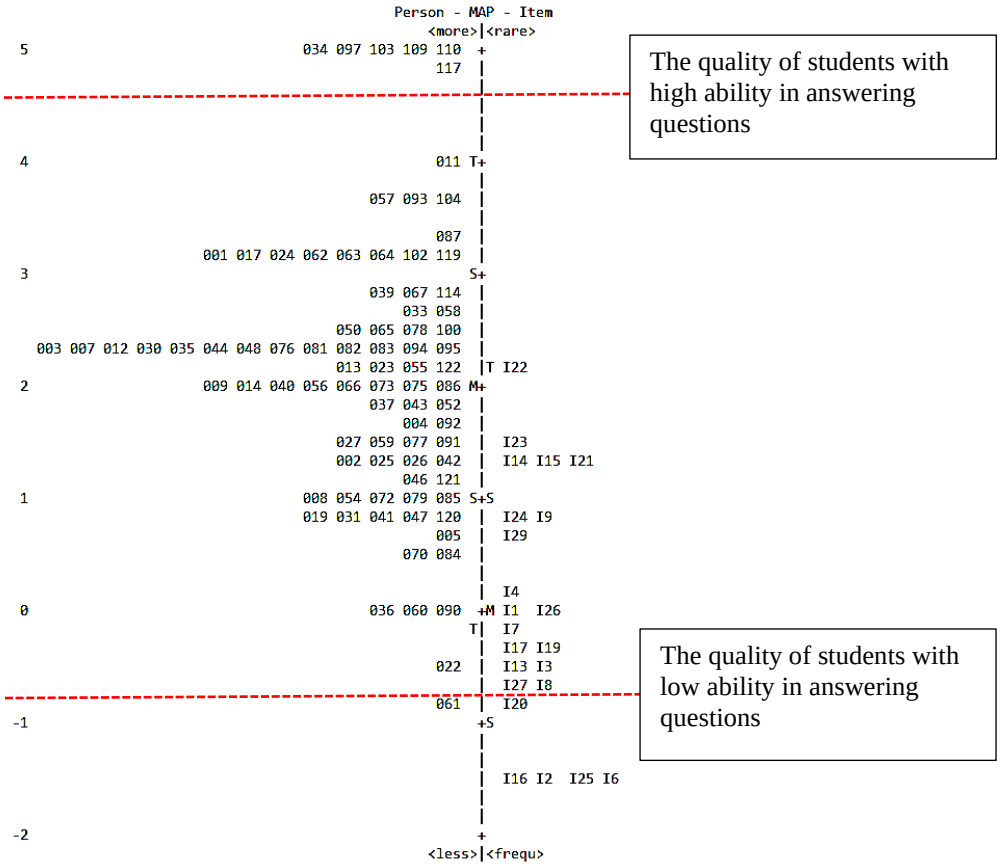

Figure 1. Wright map of students' self-regulated learning ability

To find out the difficulty of the item (item fit) can be seen in Table 6. There is a column containing logit data from each item (Measure), making it easier for researchers to see data about difficult and easy questions. That there are numbers that indicate data loss (Total Count) so that it can be read that there are 86 students who answered this question and can see the grouping on the questions. By looking at the measured value, there are four groups: very difficult, difficult, easy, and very easy. The very difficult group has questions on the label (I22, I23, I14, I15, I21). In the difficult group, there are questions on the label (I24, I9, I29, I4, I26), and in the easy group, there are questions on the label (I1, I7, I17, I19, I13, I3, I8, I27, I20), while in the very easy group there are questions on the label (I6, I16, I2, I25). In addition, there

are MNSQ outfit results, ZSTD outfit results, and PT-MEASUEURE CORR results which make it easy to see valid data using Rasch modeling criteria.

Table 6. Item Measure of self-regulated learning

Entry Number	Total Count	Measure	Infit		Outfit		PT-Measure		Item
			MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.	
17	86	2.10	1.06	.4	1.06	.4	.62	.66	I22
18	86	1.52	1.09	.7	1.14	.9	.55	.63	I23
10	86	1.41	1.31	2.1	1.31	1.9	.51	.63	I14
11	86	1.28	1.31	2.0	1.25	1.6	.57	.62	I15
16	86	1.28	.94	-.4	.90	-.6	.63	.62	I21
19	86	.88	.97	-.1	.91	-.5	.61	.59	I24
8	86	.76	1.30	1.9	1.34	1.8	.53	.58	I9
23	86	.71	.95	-.3	1.13	.8	.50	.58	I29
4	86	.20	1.26	1.5	1.12	.6	.49	.53	I4
21	86	.08	1.46	2.4	1.20	.9	.46	.52	I26
1	86	-.05	.96	-.2	.93	-.2	.50	.50	I1
6	86	-.16	.84	-.8	.88	-.4	.54	.49	I7
13	86	-.27	.76	-1.3	.65	-1.4	.56	.48	I17
14	86	-.38	1.25	1.2	1.09	.4	.46	.47	I19
9	86	-.51	1.01	.1	.68	-1.1	.52	.45	I13
3	86	-.55	.69	-1.6	.59	-1.4	.55	.45	I3
7	86	-.74	.77	-1.0	.56	-1.4	.53	.43	I8
22	86	-.74	.67	-1.6	.64	-1.1	.51	.43	I27
15	86	-.85	.71	-1.3	.57	-1.3	.50	.42	I20
5	86	-1.45	.70	-1.0	.35	-1.7	.50	.34	I6
12	86	-1.45	.84	-.5	.52	-1.1	.43	.34	I16
2	86	-1.53	.84	-.4	.62	-.7	.40	.33	I2
20	86	-1.53	.76	-.8	.52	-1.0	.41	.33	I25
Mean	86.0	.00	.98	.1	.87	-.2			
SD	.0	1.05	.23	1.2	.29	1.1			

Problem-solving ability variable

It can be seen in Figure 2 that it is the Wright map obtained from processing data on problem-solving ability test questions using Winsteps software version 4.4.2. It shows that two students occupy the high-quality section in the ability to answer questions on the labels (064P and 069P); this shows that these students can answer questions easily compared to other students. In addition, there are five students whose ability to answer questions with low quality on the label (083P, 093P, 042L, 102L, 110P). It shows that these students have difficulty answering easy or difficult questions compared to other students.

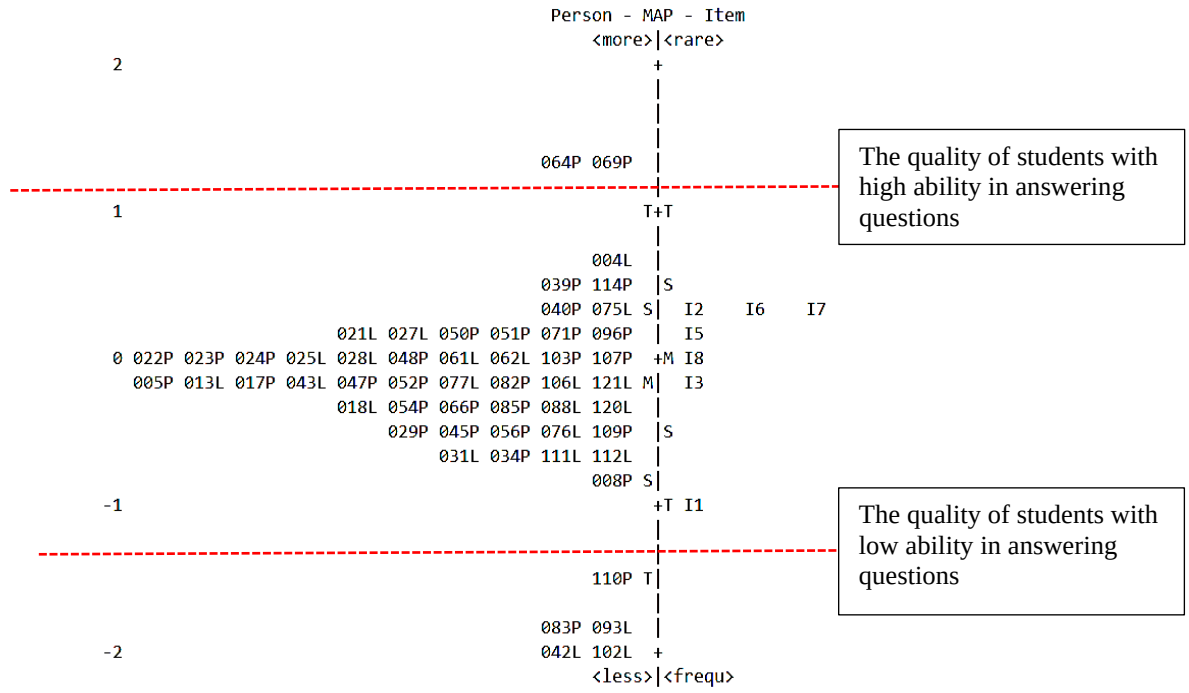

Figure 2. Wright map of students' test questions

To see the measuring value that can make it easier to determine the level of difficulty of the items in figure 3 can be seen from the logit measure value and can be put into four groups, namely very difficult, difficult, easy, and very easy. In the very difficult group, there are no questions that fall into the category. In the difficult group, there are questions with labels (I6, I2, I7, I5), and in the easy group, there are questions with labels (I8 and I3), while in the very difficult group, there are questions. with the label (I1). In addition, there is a total count that shows the amount of data that answered the item, 54 people. There are MNSQ outfit results, ZSTD outfit results, and PT-MEASUEURE CORR results which can make it easier for us to determine valid data.

Item STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
5	201	54	.41	.07	.92	-.4	.88	-.5	.59	.61	16.7	21.4	I6
2	207	54	.37	.07	1.22	1.3	1.22	1.0	.54	.61	16.7	18.9	I2
6	211	54	.35	.07	.99	.0	1.05	.3	.64	.62	11.1	20.2	I7
4	246	54	.18	.07	1.17	1.0	1.04	.3	.70	.65	16.7	18.9	I5
7	283	54	-.02	.07	.72	-1.5	.71	-1.3	.77	.69	33.3	23.7	I8
3	319	54	-.23	.08	1.23	1.0	1.18	.7	.69	.73	25.9	34.2	I3
1	444	54	-1.07	.08	.86	-.8	.89	-.5	.72	.74	24.1	20.0	I1
MEAN	273.0	54.0	.00	.07	1.02	.1	.99	.0			20.6	22.5	
S.D.	80.7	.0	.49	.00	.18	1.0	.17	.8			7.0	5.0	

Figure 3. Item Measure test questions

The relationship of self-regulated learning with problem-solving ability

Testing the product-moment correlation using the Pearson formula assisted by the SPSS application version 25 by entering the logit measure value of the questionnaire and the logit measure test value obtained from data processing through the Winsteps software version 4.4.2.

In this correlation test, the results show that the significant value obtained is 0.000 and that there is a correlation in the category. These results also show a positive value so that the relationship between the self-regulated learning variable and the problem-solving ability variable is positive. According to the relationship degree guidelines, there is a Person Correlation result of 0.776, which is included in the category of strong correlation (Fadila & Khoirunnisa, 2021). After that, the Effect Size value was tested to see how effectively self-regulated learning affects problem-solving abilities and got an effect size value of 1.035, which means that the self-regulated learning of class V students affects the ability to solve problems in the high category.

Discussion

The Rasch modeling used in this study makes it easy to process raw data by adding up integer responses for items and getting more specific results (Andrich, 2018). It happens because Rasch modeling has a mechanism to maximize test items (Fan et al., 2021). This study includes raw data in the Rasch modeling derived from the values obtained by each instrument. Therefore, it gets the logit value needed for other research tests. There are three criteria in Rasch modeling to see whether the questions used are good or not, namely by looking at the scores (MNSQ, ZSTD, and PT-Measure Corr) (Saidi & Siew, 2019). In the questionnaire instrument, six items do not meet the criteria, and on the test instrument, there is 1 item that does not meet the criteria, so the item is not suitable for use.

Table 4 and Table 5 in the research results section explain that the data derived from the independence questionnaire instrument while studying and the ability test instrument in problem-solving have entered the reliable criteria so that they are ready to carry out the following process. After that, Figure 1 and Figure 2 are Wright Maps of the questionnaires and test questions obtained from the Winsteps software version 4.4.2 so that you can see the quality of the person's abilities and the quality of each item. If you look at Figure 1, the Wright Map of the questionnaire instrument found that six students (034, 097, 103, 109, 110, and 117) who occupy the top position by answering very difficult questions are still within their abilities, so that questions that fall into the difficult category will be considered easy for them. In addition, the Wright map on the questionnaire instrument found the easiest question items, with labels (I16, I2, I25, I6), with students with the lowest abilities (061) being able to answer the easiest questions very easily, meaning that the questions were still in the category easy for low ability students. While on the Wright map, the problem-solving ability test questions in Figure 2 illustrate that two students (064P and 069P) have higher quality answering questions than the difficulty level of all item questions, making it easier for these students to work on test questions. Furthermore, it was found that five students (110P, 083P, 093L, 042L, and 102L) occupied a low-quality level and were placed under a low-quality item. It indicates that five students cannot answer or have difficulty with low or high-quality test questions.

The questions on the test instrument cover fractional material. Procedural knowledge of fractional material refers to the ability to solve problems based on proper fractions such as

addition, subtraction, multiplication, and division (Jordan et al., 2017). So students who cannot answer questions with low or high difficulty are said not to have good problem-solving abilities (Yayuk et al., 2020). In addition, the fraction material in mathematics learning provides a good basis for obtaining more advanced mathematical knowledge (Fazio et al., 2016). Students with a good understanding of fractional material can work on problems without obstacles because they have quality problem-solving abilities based on independence when learning, and they influence each other (Ansori & Herdiman, 2019).

The next discussion is about the correlation test to examine the existence of a relationship or relationship between self-regulated learning and problem-solving abilities. The results obtained from this correlation test get a significant value of 0.000 which is classified in the category there is a correlation and shows a positive value. The Pearson Correlation value was found to be 0.776, which was classified in the category of strong correlation according to the relationship degree guidelines (Fadila & Khoirunnisa, 2021). In addition, the Effect Size test conducted in this study showed a result of 1,035, which was included in the category of mutual influence at a high level. This effect size is carried out to determine the relationship between variables in a study (Prahesti & Suparji, 2021). So that it can be interpreted that students who have self-regulated learning above average will be good at solving the problems they face. While students who are not good at solving the problems they face show learning independence below average. It happens because the variables influence each other. In accordance with what was reported by Amalia et al. (2018) obtained, the results of an investigation stated that self-regulated learning and problem-solving abilities had a very strong and positive relationship between the two and concluded that the two were interrelated.

Conclusion

There is a relationship between self-regulated learning and problem-solving abilities, especially on fractions in online learning for elementary school students. It can be seen that the more students have self-regulated learning above average or high, the problem-solving abilities they have are getting better or better. Furthermore, conversely, the more students have self-regulated learning below average or low; the students' solving abilities are also less good.

The implications obtained from the results of this study are in the form of self-regulate in learning that students can improve to facilitate solving a problem, especially in solving math problems with fractions, as well as being a consideration for teachers to maximize the problem-solving abilities that exist in students. In addition, the limitations of this research are in the form of students who cannot participate because, at the time of data collection, they were still in the COVID-19 pandemic and approaching Eid al-Fitr.

Acknowledgment

The authors would like to thank the schools which participated in this research and Universitas Muhammadiyah Prof. Dr. Hamka who has provided Winsteps software version 4.4.2.

Conflicts of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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