



Interaction between RME-based blended learning and self-regulated learning in improving mathematical literacy

Novita Sari *, Zuli Nuraeni, Novika Sukmaningthias

Mathematics Education Department, Universitas Sriwijaya, South Sumatera, Indonesia

* Correspondence: novitasari@fkip.unsri.ac.id

© The Authors 2022

Abstract

Most prior studies on mathematical literacy (ML), self-regulated learning (SRL), and RME-based blended learning were carried out qualitatively. Therefore, it was necessary to test them with statistical inference. This study aimed to analyze the interaction between RME-based blended learning, conventional learning, and SRL in improving students' ML. The method used was quasi-experimental with a 2x2 factorial design. The population was students in grade 7 with a sample of 38 students (21 males and 17 females). RME-based blended learning was conducted in the experiment class, while conventional learning was in the control class. Self-regulated learning and mathematical literacy data were obtained from the questionnaire and test, respectively. Data were analyzed using the Adjusted Rank Transform Test with Two-Way ANOVA and Mann-Whitney U test. The result showed an interaction between RME-based blended learning, conventional learning, and SRL towards students' ML improvement. Students' ML improvement who received RME-based blended learning was higher than those who received conventional learning regarding the high level of SRL and vice versa at the low level. Furthermore, students' ML improvement with high SRL was slightly higher than those with low SRL after receiving RME-based blended learning and vice versa after getting conventional learning.

Keywords: blended learning; mathematical literacy; realistic mathematics education; self-regulated learning

Received: 28 May 2022 | Revised: 5 June 2022

Accepted: 14 June 2022 | Published: 1 July 2022



Introduction

Nowadays, the Indonesian education system is undergoing adjustments to the industrial revolution 4.0 era, where technology and information are developing massively and rapidly. It provides fundamental changes to human life. There are changes in the way of human activities that affect the world of work. Today, routine work can be replaced with computer systems and production machines. When technology in the 21st century can take over repetitive work, human skills, like solving complex problems, thinking critically, arguing, communicating, and collaborating, work cannot be replaced (Sari et al., 2021). These human skills become employee skills demanded in the 21st century (Levin-Goldberg, 2012). One of the fundamental skills to be developed for preparing generations in the 21st century to compete in mathematical literacy (Habibi & Suparman, 2020; Indrawati, 2020; Rizki & Priatna, 2019; Widjaja, 2011).

Mathematical literacy is an individual's ability to reason mathematically, formulate, use, and interpret mathematics to solve issues in diverse real-world contexts (Organisation for Economic Co-operation and Development, 2019). Mathematical literacy consists of seven essential mathematical skills such as (1) communication; (2) mathematizing; (3) representations; (4) reasoning and arguments; (5) devising strategies for solving problems; (6) using symbolic, formal, and technical language and operations; and (7) using mathematical tools (Organisation for Economic Co-operation and Development, 2019). These skills help individuals recognize the role of mathematics in the world and make the judgments and reasoned decisions that 21st-century societies need. For this reason, students need to be equipped with mathematical literacy to solve problems and survive in the future. However, Program for International Student Assessment (PISA) shows that students' mathematical literacy scores are deficient. Of 78 countries, Indonesia was on rank 73, with 379 of an average score (489) (Aziz & Amidi, 2021; Schleicher, 2019). One of the causes is that students are still accustomed to solving problems with procedural and concrete answers (Muzaki & Masjudin, 2019). In addition, another skill is needed to support the achievement of mathematical literacy, namely self-regulated learning, especially during the current pandemic (Hidayat et al., 2018).

Self-regulated learning is defined as learning that is primarily influenced by students' thoughts, feelings, techniques, and behaviors, which are geared toward reaching goals (Hidayat et al., 2018). Self-regulated learning demonstrates a student's ability to choose his or her learning technique (Kholifasari et al., 2020). Students who desire to learn, solve problems and are responsible for fulfilling their obligations as they possess self-regulated learning (Fitriasari et al., 2018). Nevertheless, the low self-regulated learning is due to a lack of confidence in abilities, low motivation for self-study, and a less conducive learning environment (Arifin & Herman, 2018).

The low mathematical literacy of students is affected by the lack of self-regulated learning and teacher-centered learning, so students become passive and only receive information from the teacher (Babys, 2016; Kholifasari et al., 2020). Research on mathematical literacy has been conducted by reviewing the aspects of student self-regulated learning. According to findings of the qualitative study, students who have high self-regulated learning have almost all aspects of mathematical literacy, while students who have low self-regulated learning do not have

mathematical literacy in problem-solving (Fahmy et al., 2018; Kholifasari et al., 2020; Yanuarto & Qodariah, 2020). Therefore, innovations in learning are needed to accommodate students in developing self-regulated learning and students' mathematical literacy. Learning models that can be applied are blended learning (Angreanisita et al., 2021; Dianawati et al., 2018; Fitriasaki et al., 2018) and Realistic Mathematics Education (RME) (Arisinta et al., 2019; Dianawati et al., 2018; Hilaliyah et al., 2019; Kusumaningrum, 2016).

Blended learning is a type of innovative learning that blends face-to-face classroom learning (offline learning) with online learning (utilizing ICT/internet) (Dianawati et al., 2018; Fitriasaki et al., 2018; Sari et al., 2020). It enables students to learn anywhere and anytime as long as it is connected to the internet. It also has the potential to promote self-regulated learning. Furthermore, technology-based instruction can help students enhance their mathematical literacy (Indrawati, 2020). Likewise, offline learning in blended learning can complement online learning to provide reinforcement and stabilization, especially in learning mathematics. Besides, an approach still provides space for students to experience meaningful learning is necessary. In addition to blended learning, RME is the right choice for training mathematical literacy and self-regulated learning (Arisinta et al., 2019; Babys, 2016; Dianawati et al., 2018; Kusumaningrum, 2016).

Wijaya stated that RME is a mathematics learning approach derived from Freudenthal's view that mathematics is a human activity (Hilaliyah et al., 2019). Furthermore, Zulkardi and Putri explained that RME is one of the lessons that emphasize context as a starting point for learning in building mathematical models, concepts, and motivations to make the learning process more meaningful (Arisinta et al., 2019). It suits the definition of mathematical literacy that students can apply mathematics in solving problems related to real-life contexts. In addition, RME can create a conducive learning environment so that students get the opportunity to construct their knowledge (Kusumaningrum, 2016). However, implementing RME in mathematics learning today must be adapted to the development of science and technology as a form of innovation. The collaboration between RME and blended learning can be used as a solution to the problem of low learning independence and students' mathematical literacy.

Several studies about mathematical literacy and self-regulated learning have been conducted by Yanuarto & Qodariah (2020), Kholifasari et al. (2020), and Auliya et al. (2021), and Agustiani et al. (2021). These studies described students' mathematical literacy seen from self-regulated learning qualitatively. In addition, a previous study about the RME approach has been done. RME approach effectively improves students' mathematical literacy (Auliya et al., 2021). This approach also improved students' self-regulated learning, with the mean of students being categorized as very good (Arisinta et al., 2019). Research about blended learning was carried out (Aritonang & Safitri, 2021; Yanto & Retnawati, 2018). Blended learning influenced the students' mathematical literacy during the coronavirus pandemic (Aritonang & Safitri, 2021). Another research finding was that blended learning could help students improve their self-regulated learning in mathematics. However, not many prior studies on mathematical literacy (ML) and self-regulated learning (SRL) were conducted by implementing learning that can facilitate students to develop both. RME-based blended learning can be a solution that can cover ML and SRL. Moreover, most of the research related to those was carried out in

qualitative or descriptive research. Hence, it is necessary to test with statistical inference. Based on the analysis above, students' self-regulated learning and RME-based learning should be expected to affect students' mathematical literacy. Therefore, this study aims to examine the interaction between RME-based blended learning, conventional learning, and SRL towards improving students' ML.

Methods

This research was experimental research with a Quasi-Experimental design. It was because the samples were not grouped randomly but using existing classes. The research design was a 2x2 factorial design. The independent variables consisted of: (1) learning model, consisting of RME-based blended learning (A_1) and conventional learning (A_2); and (2) SRL level, consisting of high (B_1) and low (B_2), while the dependent variable is the improvement of ML. Furthermore, the 2x2 factorial design is represented in Table 1.

Table 1. A 2x2 factorial design for RME-based blended learning, SRL, and ML

SRL Levels	Learning Models	
	RME-Based Blended Learning (A_1)	Conventional Learning (A_2)
High (B_1)	A_1B_1	A_2B_1
Low (B_2)	A_1B_2	A_2B_2

Based on Table 1, there are four groups of students, namely A_1B_1 , A_1B_2 , A_2B_1 , and A_2B_2 . A_1B_1 and A_2B_1 are groups of students with high levels of SRL who received RME-based blended learning and conventional learning, respectively. In addition, A_1B_2 and A_2B_2 are groups of students with low levels of SRL who received RME-based blended learning and conventional learning, respectively.

The population of this study was seventh graders. There were 21 males and 17 females among the 38 students in the sample. They were in the experiment and control classes, each of which was 19 people. Before conducting the research, the classes were first statistically tested for equivalence. The experiment and control classes were assigned at random. The treatment, RME-based blended learning, was in the experiment class, whereas the control class had conventional learning.

The instrument used were a questionnaire about self-regulated learning and ML test. The validity of questionnaire items and test items were high and very high. The Cronbach's Alpha values for the questionnaire and test were 0.906 and 0.702, which were categorized as very high and high reliability respectively.

The SRL data were obtained from the questionnaire before the treatment was given, while the data on ML was obtained from the pretest and posttest. The grouping of SRL levels used the criteria in Table 2 since it is classified as ordinal data.

Table 2. The criteria for SRL levels

Interval	Levels
$x \geq \text{Median}$	High
$x < \text{Median}$	Low

The ML test was in the form of an essay that had four problems about multiplication and division of algebraic expression. The assessment rubric follows PISA standards: full credit, partial credit, and no credit. The improvement of students' ML was calculated by the normalized gain (N-gain) and classified as N-gain according to Hake (Nani & Kusumah, 2015) as follows in Figure 3.

Table 3. N-gain (g) categorized

$n\text{-gain } (g)$	Category
$g > 0.7$	High
$0.3 < g \leq 0.7$	Moderate
$g \leq 0.3$	Low

Data were analyzed using the Adjusted Rank Transform Test with Two-Way ANOVA (Leys & Schumann, 2010). It was used to determine the interaction between RME-based blended learning, conventional learning, and SRL in improving students' ML. Further testing for the basic influence of learning models and SRL levels on ML improvement were conducted using the Mann-Whitney U test. Overall, the data from this study was processed using SPSS 22.0.

Results

RME-based blended learning was implemented in the experimental class, and conventional learning was in the control class. This study began with the distribution of a questionnaire to measure the level of student SRL as a research factor, followed by the ML pre-test. Furthermore, the treatment was conducted in two meetings and continued with a post-test.

The first step was to analyze the pre-test data to see the ML equivalence of students in each class by testing the difference between the two means. On the pre-test data, the normality and homogeneity tests were completed first. The normality test used the Kolmogorov-Smirnov (K-S) test. The test requirements are that H_0 is accepted if the value of sig. (2-tailed) is greater than the significance level of 0.05, and vice versa. Table 4 shows the normality test results on ML data from the experiment and control classes.

Table 4. Normality test on ML pre-test using one-sample Kolmogorov-Smirnov test

Learning Model	N	Min	Max	Mean	Std. Deviation	Asymp. Sig. (2-tailed)
RME-based blended learning	19	0.00	25.00	2.6316	6.69129	0.000 ^c
Conventional learning	19	0.00	25.00	2.6316	6.69129	0.000 ^c

Based on Table 4, the means and standard deviations of the students' ML on pretest data in both classes are the same, namely 2.6316 and 6.69129, respectively. In addition, the value of asymp. sig. (2-tailed) for the experiment and control classes is 0.000, which is less than the

significance criterion of 0.05, indicating that H_0 is rejected. Each of the data points has a non-normal distribution. Furthermore, because the data were not distributed normally, the experiment and control classes used non-parametric statistics, namely the Mann-Whitney U test, to determine the equivalence of the initial ML. The null hypothesis states that there is no difference in the mean of initial ML between students who received RME-based blended learning and those who got conventional instruction. Accept H_0 if sig. (2-tailed) is greater than the significance level of $\alpha = 0.05$, according to the test conditions. H_0 is rejected otherwise. The outcomes of the Mann-Whitney U test are shown in Table 5.

Table 5. Mann-Whitney U test on ML pre-test

	ML Pre-test
Mann-Whitney U	180.500
Asymp. Sig. (2-tailed)	1.000

In Table 5, H_0 is acceptable because the value of sig. (2-tailed) is greater than the significance level of $\alpha = 0.05$. It suggests that the initial ML means of students who received RME-based blended learning and those who received conventional learning are not significantly different. It shows that the study was began with students' ML in relatively similar conditions.

The interaction between RME-based blended learning, conventional learning, and SRL in improving students' ML

To determine the interaction between RME-based blended learning, conventional learning, and SRL in improving students' ML, N-gain of ML data were analyzed using two-way ANOVA utilizing SPSS 22.0. Descriptive statistics of N-gain of students' ML, such as means, standard deviations, minimums, and maximums scores from experiment and control class, are presented in Table 6.

Table 6. Descriptive statistics of N-gain of students' ML

Self-Regulated Learning Levels	Learning	N	Mean	Category	Std. Deviation
High (B_1)	RME-based blended learning (A_1)	12	0.338	Moderate	0.383
	Conventional (A_2)	9	0.016	Low	0.048
Low (B_2)	RME-based blended learning (A_1)	7	0.161	Low	0.373
	Conventional (A_2)	10	0.062	Low	0.135

Based on Table 6, only the mean of students' ML improvement in A_1B_1 is in the medium categorized, while the other three groups are low. Furthermore, the normality test was carried out as a prerequisite for two-way ANOVA. Table 8 shows the normality test results on the N-gain of ML in the experiment class and those in the control class.

Table 7. Normality tests on the N-gain of ML using one-sample Kolmogorov-Smirnov test

	A_1B_1	A_1B_2	A_2B_1	A_2B_2
N	12	7	9	10
Asymp. Sig. (2-tailed)	0.147 ^c	0.001 ^c	0.000 ^c	0.000 ^c

Table 7 shows the asymp value. sig. (2-tailed) for all groups are 0.000 and less than the significance level $\alpha=0.05$ so H_0 is rejected. It means that the N-gain of ML of all groups are non-normal distributions. Since all the N-gain of ML in groups were not normally distributed, N-gain data were transformed using the Adjusted Rank Transform test followed by two-way ANOVA (Leys & Schumann, 2010). The analysis of the adjusted rank data using a two-way ANOVA with a significance level of $\alpha=0.05$ can be seen in Table 8.

Table 8. Summary of two-way ANOVA

Source	Corrected Model	Intercept	A	B	A * B
F	7.432	277.613	1.942	0.942	21.040
Sig.	0.001	0.000	0.172	0.339	0.000

Based on table 8, there are the values of F and sig. in each A, B, and the interaction between A and B. First, the value of $F(A) = 1.942$ and $\text{sig.} = 0.172 > 0.05$ so H_0 is not rejected. It means that there is no difference in the improvement of students' ML between students who received RME-based blended learning and who received conventional learning. Second, the value of $F(B) = 0.942$ and $\text{sig.} = 0.339 > 0.05$ so that H_0 is not rejected. It means that there is no difference in the improvement of students' ML between high and low levels of SRL. Finally, the value of $F(A*B) = 21.040$ and $\text{sig.} = 0.000 < 0.05$ so that H_0 is rejected. It means that there is a significant interaction between RME-based blended learning, conventional learning, and SRL towards students' ML improvement. Since there is a significant interaction, further analyses were performed to know the simple effect of RME-based blended learning and SRL on the improvement of students' ML separately.

The analysis of the simple effect

A simple effect analysis must be carried out to examine the effect of differences between means of the improvement of students' ML in the four groups. From the corrected model row in Table 8, the value of $F = 7.432$ and $\text{sig.} = 0.001 < 0.05$ so H_0 is rejected. It can be said that there is a significant difference between means of the improvement of students' ML among the four groups. For this reason, the difference between RME-based blended learning and conventional learning, in terms of SLR levels, is tested and the difference between high SRL and low SRL, in terms of learning models, is also tested. The criteria of a one-tailed test are to reject H_0 if the value of $\text{sig. (2-tailed)}/2$ is less than the significance level $\alpha = 0.05$, and vice versa. The results of the Mann-Whitney U test are presented in Table 9 and Table 10 below.

Table 9. Mann-Whitney U test in terms of SRL

Self-Regulated Learning Levels	Learning Models	N	Mean Rank	Mann-Whitney U	sig. (2-tailed)
High (B_1)	RME-based blended learning (A_1)	12	13.54	23.5	0.025/2=0.0125
	Conventional (A_2)	9	7.61		
Low (B_2)	RME-based blended learning (A_1)	7	5.43	10	0.009/2=0.0045
	Conventional (A_2)	10	11.50		

Table 10. Mann-Whitney U test for N-gain ML in terms of learning models

Learning Models	Self-Regulated Learning Level	N	Mean Rank	Mann-Whitney U	sig. (2-tailed)
RME-based blended learning (A_1)	High (B_1)	12	12.33	14	0.016/2=0.008
	Low (B_2)	7	6.00		
Conventional (A_2)	High (B_1)	9	5.89	8	0.001/2=0.0005
	Low (B_2)	10	13.7		

In Table 9, for the high level of SRL, the mean rank of A_1B_1 is more than those of A_2B_1 and sig. (2-tailed)/2 = 0.025/2 = 0.0125 is less than 0.05. It means to reject H_0 . Hence, the ML of students who received RME-based blended learning is significantly higher than students who received conventional learning, in terms of the high level of SRL. However, for the low level of SRL, the means of A_1B_2 is less than those of A_2B_2 and sig. (2-tailed)/2 = 0.009/2 = 0.0045 is less than 0.05. It means to reject H_0 . In consequence, the ML of students who received conventional learning is significantly higher than students who received RME-based blended learning, in terms of the low level of SRL.

In Table 10, for RME-based blended learning, the mean of A_1B_1 is more than those of A_1B_2 . The sig. (2-tailed)/2 = 0.016/2 = 0.008 is less than 0.05 so it rejects H_0 . Thus, the ML of students with high SRL is significantly higher than students with low SRL after getting RME-based blended learning. However, for conventional learning, the mean of A_2B_1 is less than those of A_2B_2 . The sig. (2-tailed)/2 = 0.001/2=0.0005 is less than 0.05 so it rejects H_0 . Therefore, the ML of students with low SRL is significantly higher than students with high SRL after getting conventional learning.

Discussion

The result showed that there had been a significant interaction between RME-based blended learning, conventional learning, and SRL in improving students' ML. It is in line with the conclusion of previous research that there was an interaction between learning models and SRL on mathematics learning outcomes (Putri & Wardika, 2020). In this study, RME-based blended learning was the learning model used, while ML was the learning outcome.

RME-based blended learning integrates students' activities in learning mathematics and links it to reality. It is called mathematics as a human activity that mathematizes real-world experience (Freudenthal, 2002; van den Heuvel-Panhuizen, 2020). RME-based blended

learning provides opportunities for students to rediscover mathematical concepts. In its implementation, students are given contextual problems as a starting point. In RME, there is the term *mathematizing* which is also a skill in mathematical literacy. *Mathematizing* entails converting a real-world problem into a strictly mathematical form, interpreting, and evaluating a mathematical outcome or a mathematical model related to the original problem (Organisation for Economic Co-operation and Development, 2019). RME with innovation combined with blended learning provided broad opportunities for students to prepare themselves to study, repeat material, and explore knowledge from various sources without limitations of time and place (Dianawati et al., 2018). In addition, blended learning improved SRL since the learning process is carried out independently (Yuliati & Saputra, 2020).

Even though there was an interaction, the learning model factor did not significantly affect the improvement of ML between students who received RME-based blended learning and conventional learning, as well as the self-regulated learning factor. These main effects of either the learning model or SRL can be misleading because it cannot be the only thing to interpret their impact on ML improvement. In a previous study, students, who were getting RME-based blended learning, attained higher ML than conventional learning (Dianawati et al., 2018). Moreover, SRL significantly impacts students' ML so that it can determine the quality of learning (Angreanisita et al., 2021). It was in line with the research result carried out by Wijayanti and Wardono (2020). In their study, the variable of SRL and ML had a very strong and positive relationship. The SRL had an effect of 55.3% on the increase or the decrease in ML and 44.7% caused by other factors. Thus, the simple effect analysis gave further information about the interaction between RME-based blended learning, conventional learning, and self-regulated learning in improving students' mathematical literacy.

The simple effects analyses of the learning model informed two things. First, the ML of students who received RME-based blended learning was significantly higher than that of conventional learning in terms of the high level of SRL. Second, the ML of students who received conventional learning was significantly higher than that of RME-based blended learning in terms of the low level of SRL. Each RME-based blended learning and conventional learning improve ML for students with high SRL and students with low SRL, respectively. The inconsistency of the learning model in giving a better effect can be one of the causes of the lack of influence of the learning model on increasing ML. RME-based blended learning can train students' ML as the results of research conducted by Arisinta et al. (2019). It can be seen from their research result that the average ML in the RME-based blended learning is better than in the expository learning.

On the contrary, conventional learning is learning where the teacher's role is more than that of the students. Students with low SRL are accustomed to receiving any information given by the teacher without trying to find out the material concepts for themselves. Therefore, the achievement of learning outcomes in students with low SRL was more optimal through more guidance or encouragement from the teacher (Putri & Wardika, 2020).

The simple effects analyses of SRL levels gave two further information as well. First, only students with high SRL had a significant improvement on ML after attaining RME-based blended learning. On the contrary, low SRL students surprisingly experienced an increase in

ML through conventional learning. It is one of the factors causing no significant effect of SRL levels on increasing students' ML when viewed from learning models. It is in line with a previous study that students with higher self-regulated learning do not always have high mathematical literacy abilities, and vice versa (Angreanisita et al., 2021). However, other studies showed that students with high SRL would have high mathematical literacy abilities (Fahmy et al., 2018; Kholifasari et al., 2020; Yanuarto & Qodariah, 2020). It was because students with high SRL had better arranged a good learning scenario and understood the benefits and drawbacks of learning. According to the humanistic theory, the learning process is successful when students understand themselves and their surroundings well until they actualize themselves as possible (Qodir, 2017).

On the contrary, students with low SRL will affect the low ML. Therefore, teachers need to find the right learning to resolve this problem. Based on the results of this study, conventional learning was not a flawed learning model for students with low SRL.

The research results that have been stated above occur for several reasons, especially from conventional learning. The teacher provided information through *WhatsApp* groups in conventional learning and gave assignments. In the learning process, the teacher explained the subject matter, examples of how to solve problems and exercises. Students paid close attention to the teacher's explanation, remembered the teacher's explanation, and worked on the exercises. Before students worked on the exercises, the teacher usually gave time for students to ask questions about things they did not understand, and the teacher explained them again. It was very different from learning in the experimental class.

In RME-based blended learning, students got facilitated by *Google Classroom* and *WhatsApp* groups to learn materials. They discussed the materials in the *Google Classroom* before they learned in synchronous learning. In the *Google Classroom*, student worksheets were available. It was developed using the five RME characteristics and mathematical literacy problems. It can facilitate students getting used to solving mathematical literacy problems. The existence of interactivity in the process of completing students' worksheets can help students understand and solve problems so that students get better mathematical literacy. However, only a few students actively discussed in groups at synchronous times due to several factors. Meanwhile, these activities do not occur in conventional learning.

Conclusion

Five things can be found in this study. First, there is a significant interaction between RME-based blended learning, conventional learning, and self-regulated learning towards students' ML improvement. Second, the ML of students who received RME-based blended learning was significantly higher than that of conventional learning regarding the high level of SRL. Third, the ML of students who received RME-based blended learning was not significantly higher than that of conventional learning regarding the low level of SRL. Fourth, the ML of students with high SRL was slightly higher than students with low SRL after getting RME-based blended learning. Fifth, the ML of students with high SRL was not significantly higher than those with

low SRL after receiving RME-based conventional learning. The results of this study can be used as input for teachers and prospective teachers in improving the quality of teaching by paying attention to appropriate learning models and building students' SRL to improve students' learning outcomes, especially mathematical literacy skills. In addition, other researchers can use the results and findings of this study to conduct related research. The limitation of this study is the small number of samples, so it still does not describe the actual situation.

Acknowledgment

The authors would like to thank Universitas Sriwijaya for sponsoring this research through DIPA of Public Service Agency of Universitas Sriwijaya 2021 with SP DIPA-023.17.2.677515/2021, on November 23, 2020. In compliance with the Rector's Decree Number: 0007/UN9/SK. LP2M.PT/2021, on April 27, 2021.

Conflicts of Interest

There are no conflicts of interest among the authors of this manuscript.

References

- Agustiani, S., Agustiani, N., & Nurcahyono, N. A. (2021). Analisis berpikir literasi matematika berdasarkan kemandirian belajar siswa SMP [Analysis of mathematical literacy thinking based on self-regulated learning of junior high school students]. *EQUALS: Jurnal Ilmiah Pendidikan Matematika*, 4(2), 67–78. <https://doi.org/10.46918/equals.v4i2.966>
- Angreanisita, W., Mastur, Z., & Rochmad. (2021). Mathematical literacy seen from learning independency in blended learning with project based learning assisted by moodle. *Unnes Journal of Mathematics Education Research*, 10(A), 155–161. <https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/36302/14972>
- Arifin, F., & Herman, T. (2018). Pengaruh pembelajaran e-learning model web centric course terhadap pemahaman konsep dan kemandirian belajar matematika siswa [The effect of e-learning web centric course model on students' understanding mathematics concepts and self-regulated learning]. *Jurnal Pendidikan Matematika*, 12(2), 1–12.
- Arisinta, R., As'ari, A. R., & Sa'dijah, C. (2019). Realistic mathematics education untuk meningkatkan kemandirian belajar matematika [Realistic mathematics education to increase the self-regulated in learning mathematics]. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, 4(6), 738–745. <https://doi.org/10.17977/jptpp.v4i6.12493>
- Aritonang, I., & Safitri, I. (2021). Pengaruh blended learning terhadap peningkatan literasi matematika siswa [The effect of blended learning on increasing students' mathematical literacy]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(1), 735–743. <https://doi.org/10.31004/cendekia.v5i1.555>
- Auliya, N. M., Suyitno, A., Asikin, M., Semarang, U. N., & Semarang, U. N. (2021). Kemampuan literasi matematis ditinjau dari kemandirian belajar di MTs Darul Hikmah Kedung Jepara [Mathematical literacy ability in terms of self-regulated learning at MTs Darul Hikmah Kedung Jepara]. *Jurnal Kajian Pembelajaran Matematika*, 5(2), 11–17. <http://journal2.um.ac.id/index.php/jkpm/article/view/26500/9148>

- Aziz, A., & Amidi, A. (2021). Development of android-based interactive learning media on statistics. *Unnes Journal of Mathematics Education*, 10(3), 244–250.
- Babys, U. (2016). Kemampuan literasi matematis space and shape dan kemandirian siswa SMA pada discovery learning berpendekatan RME-PISA [Mathematical literacy skills of space and shape and independence of high school students in discovery learning with the RME-PISA approach]. *Jurnal Pendidikan Matematika Indonesia*, 1(2), 43–49. <https://doi.org/10.26737/jpmi.v1i2.82>
- Dianawati, R. N., Kartono, & Wardono. (2018). PMRI learning with blended learning strategy to improve mathematical literacy skill. *Unnes Journal of Mathematics Education Research*, 7(1), 79–85. <https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/24333/11172>
- Fahmy, A. F. R., Wardono, W., & Masrukan, M. (2018). Kemampuan literasi matematika dan kemandirian belajar siswa pada model pembelajaran RME berbantuan geogebra [Mathematical literacy ability and student's self-regulated learning in the geogebra-assisted RME learning model]. *Prisma, Prosiding Seminar Nasional Matematika*, 1(22), 559–567. <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/20198/9576>
- Fitriasari, P., Tanzimah, & Sari, N. (2018). Kemandirian belajar mahasiswa melalui blended learning pada mata kuliah metode numerik [Students' self-regulated learning through blended learning in numerical methods course]. *Jurnal Elemen*, 4(1), 1–8. <https://doi.org/10.29408/jel.v4i1.439>
- Freudenthal, H. (2002). *Revisiting Mathematics Education: China Lectures* (Vol. 9). Kluwers Academic Publishers.
- Habibi & Suparman. (2020). Literasi matematika dalam menyambut PISA 2021 berdasarkan kecakapan abad 21 [Mathematical literacy in welcoming PISA 2021 based on 21st century skills]. *JKPM: Jurnal Kajian Pendidikan Matematika*, 6(1), 57–64. <https://doi.org/10.30998/jkpm.v6i1.8177>
- Hidayat, R., Roza, Y., & Murni, A. (2018). Peran penerapan model problem based learning (PBL) terhadap kemampuan literasi matematis dan kemandirian belajar [The role of the implementation of problem based learning (PBL) models on mathematical literacy skills and self-regulated learning]. *Journal for Research in Mathematics Learning*, 1(3), 213–218. <https://doi.org/10.24014/juring.v1i3.5359>
- Hilaliyah, N., Sudiana, R., & Pamungkas, A. S. (2019). Pengembangan modul realistic mathematics education bernilai budaya banten untuk mengembangkan kemampuan literasi matematis siswa [Development of realistic mathematics education module with the value of Banten culture to develop students' mathematical lite]. *Jurnal Didaktik Matematika*, 6(2), 121–135. <https://doi.org/10.24815/jdm.v6i2.13359>
- Indrawati, F. (2020). Peningkatan kemampuan literasi matematika di era revolusi industri 4.0 [Improving mathematical literacy skills in the era of the industrial revolution 4.0]. In I. A. D. Astuti, I. Y. Okyranida, Y. B. Bhakti, & S. Noer (Eds.), *Proceeding of Seminar Nasional Sains* (pp. 382–386). <http://www.proceeding.unindra.ac.id/index.php/sinasis/article/view/4064>
- Kholifasari, R., Utami, C., & Mariyam, M. (2020). Analisis kemampuan literasi matematis siswa ditinjau dari karakter kemandirian belajar materi aljabar [Analysis of students' mathematical literacy skills in terms of self-regulated learning character on algebraic material]. *Jurnal Derivat: Jurnal Matematika Dan Pendidikan Matematika*, 7(2), 117–125. <https://doi.org/10.31316/j.derivat.v7i2.1057>
- Kusumaningrum, D. S. (2016). Peningkatan kemampuan penalaran dan kemandirian belajar matematik melalui pendidikan matematika realistik indonesia (PMRI) [Improving reasoning ability and self-regulated in learning mathematics through Indonesian realistic mathematics education]. *Jurnal Buana Ilmu*, 1(1), 10–20.

- <https://doi.org/10.36805/bi.v1i1.94>
- Levin-Goldberg, J. (2012). Teaching generation techX with the 4Cs: Using technology to integrate 21st century skills. *Journal of Instructional Research*, 1, 59–66. <https://doi.org/10.9743/JIR.2013.8>
- Leys, C., & Schumann, S. (2010). A nonparametric method to analyze interactions: The adjusted rank transform test. *Journal of Experimental Social Psychology*, 46(4), 684–688. <https://doi.org/10.1016/j.jesp.2010.02.007>
- Muzaki, A., & Masjudin. (2019). Analisis kemampuan literasi matematis siswa [Analysis of students' mathematical literacy skills]. *Mosharafa: Jurnal Pendidikan Matematika*, 8(3), 493–502. <https://doi.org/10.31980/mosharafa.v8i3.557>
- Nani, K. L., & Kusumah, Y. S. (2015). The effectiveness of ICT-assisted project-based learning in enhancing students' statistical communication ability. *International Journal of Education and Research*, 3(8), 187–196. <https://www.ijern.com/journal/2015/August-2015/16.pdf>
- Organisation for Economic Co-operation and Development. (2019). *PISA 2018 assessment and analytical framework*. OECD Publishing. <https://doi.org/10.1787/b25efab8-en>
- Putri, N. W. S., & Wardika, I. W. G. (2020). Interaksi model pembelajaran tandur berbantuan media Geogebra terhadap hasil belajar mahasiswa ditinjau dari kemandirian belajar [Interaction of the tandur learning model assisted by Geogebra media on student learning outcomes in terms of self-regulated l. *Paedagogia: Jurnal Kajian, Penelitian Dan Pengembangan Kependidikan*, 11(2), 99–105.
- Qodir, A. (2017). Teori belajar humanistik dalam meningkatkan prestasi belajar siswa [Humanistic learning theory in improving student achievement]. *PEDAGOGIK: Jurnal Pendidikan*, 4(2), 188–202.
- Rizki, L. M., & Priatna, N. (2019). Mathematical literacy as the 21st century skill. *Journal of Physics: Conference Series*, 1157(4), 042088, 42088. <https://doi.org/10.1088/1742-6596/1157/4/042088>
- Sari, N., Fitriyani, P., & Octaria, D. (2020). Blended learning with schoology in learning macromedia flash-based instructional media. *Journal of Physics: Conference Series*, 1480(1), 012053. <https://doi.org/10.1088/1742-6596/1480/1/012053>
- Sari, N., Sukmaningthias, N., Nuraeni, Z., Helen, R., Hasanah, U., & Nasya, K. (2021). Developing mathematical literacy task in multiplication and division of algebraic expression. In N. Sari, Z. Nuraeni, N. Sukmaningthias, S. Scristia, & R. H. Simarmata (Eds.), *Proceedings of the International Conference of Mathematics and Mathematics Education (I-CMME 2021)*, 597, 203–209. <https://doi.org/10.2991/assehr.k.211122.028>
- Schleicher, A. (2019). *PISA 2018: Insights and interpretations*. OECD Publishing. https://www.oecd.org/pisa/PISA_2018_Insights_and_Interpretations_FINAL_PDF.pdf
- van den Heuvel-Panhuizen, M. (Ed). (2020). *International reflections on the Netherlands didactics of mathematics: Visions on and experiences with realistic mathematics education*. Springer Open. https://doi.org/10.1007/978-3-030-20223-1_5
- Widjaja, W. (2011). Towards mathematical literacy in the 21st century: Perspectives from Indonesia. *Southeast Asian Mathematics Education Journal*, 1(1), 75–84. <https://doi.org/10.46517/seamej.v1i1.12>
- Wijayanti, P., & Wardono. (2020). Analisis literasi matematika ditinjau dari kemandirian belajar siswa SMP pada pembelajaran DAPIC- problem-solving pendekatan PMRI berbantuan Schoology [Analysis of mathematical literacy in terms of self-regulated learning independence of junior high school. *PRISMA, Prosiding Seminar Nasional Matematika*, 3, 670–678. <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/37755>
- Yanto, B., & Retnawati, H. (2018). Dapatkah model blended learning mempengaruhi

- kemandirian belajar matematika siswa? [Can the blended learning model affect students' self regulated in learning mathematics?]. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 7(3), 324–333. <https://doi.org/10.24127/ajpm.v7i3.1559>
- Yanuarto, W. N., & Qodariah, L. N. (2020). Deskripsi literasi matematis siswa SMP ditinjau dari kemandirian belajar [Description of the mathematical literacy of junior high school students in terms of self-regulated learning]. *MATH LOCUS: Jurnal Riset dan Inovasi Pendidikan Matematika*, 1(2), 41–53. <https://doi.org/10.31002/mathlocus.v1i2.1070>
- Yuliati, Y., & Saputra, D. S. (2020). Membangun kemandirian belajar mahasiswa melalui blended learning di masa pandemi covid-19 [Building student self-regulated learning through blended learning during the covid-19 pandemic]. *Jurnal Elementaria Edukasia*, 3(1), 142–149.