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The Effect of the Realistic Mathematics Education (RME) Approach on Mathematical Literacy Ability Reviewed from Self-efficacy in Algebraic Materials

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Mathematical literacy plays a crucial role as a life skill. However, the level of mathematical literacy in Indonesia remains relatively low. One alternative learning approach considered to support the development of mathematical literacy is the Realistic Mathematics Education (RME) approach. Learning activities are also influenced by an individual's confidence in their own abilities, commonly referred to as self-efficacy. This study aims to examine the effect of the RME approach on mathematical literacy, the impact of self-efficacy on mathematical literacy, and the interaction between the RME approach and self-efficacy in relation to mathematical literacy. This research employs a quantitative design with a quasi-experimental method, using a non-equivalent pre-test–post-test control group design. The findings indicate that students taught using the RME approach demonstrated stronger mathematical literacy than those taught through direct instruction; students with higher levels of self-efficacy also showed higher levels of mathematical literacy; and there was no significant interaction between the learning approach and self-efficacy on mathematical literacy. Future researchers are advised to ensure student attendance at every session, broaden the research sample, and give careful consideration to the allocation of learning time.

Keywords: RME approach; mathematical literacy; self-efficacy; algebraic

I. INTRODUCTION

One of the things needed to develop 21st century skills is mathematical literacy (Nurmasari *et al.*, 2024). Mathematical literacy skills are the ability to implement mathematics in solving everyday problems and describe how students identify and understand the problems they have learned in all aspects of life or in different contexts (Fauzan *et al.*, 2024; Kolar & Hodnik, 2021; Novita & Herman, 2021). Mathematical literacy plays an important role as one of life skills (Harisman *et al.*, 2023).

The importance of mathematical literacy skills to be developed in students is not in line with mathematics literacy skills in Indonesia which are in a low position. One of the indicators can be analysed from the PISA results (Programme for International Student Assessment) which is used to test students' abilities in the field of mathematics (Rusdi *et al.*, 2023). Based on the 2022 PISA results, it shows a decrease in mathematics literacy scores by 13 points when compared to the 2018 PISA results (OECD, 2022)). Indonesia has also always been ranked in the bottom 10 while participating in PISA since 2000 until now (Harisman, *et al.*, 2023). In addition, from the Indonesian government program, namely Minimum Competency Assessment (AKM) as a national evaluation shows that the achievement of the minimum competency limit of numeracy skills is still less than 50% (Ministry of Education, Culture, Research, 2023). This shows that many students still do not meet the minimum requirements. This situation illustrates the low ability of mathematical literacy in Indonesia (Aisyah & Juandi, 2022; Kusmaryono & Kusumaningsih, 2023). It was strengthened

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by the results of the initial test scores to 64 students at SMP Negeri 1 Sawangan who got an average of 26.05 out of a maximum score of 100. This shows that students have low mathematical literacy skills.

Low math literacy ability is caused by many factors. Referring to the results of the interview, students admitted that they had difficulty in understanding mathematical literacy problems and were not used to solving mathematical problems that are relevant in the real world and daily life. In line with Jailani *et al.* (2020) The cause of low math literacy is that students have difficulty identifying problems in real-world contexts. The same thing was also expressed by Kintoko *et al.* (2025), lack of experience in solving contextual problems is an obstacle in improving mathematical literacy. In addition, the learning approach that is often applied is direct learning where students only receive the material given by the teacher. In ideal learning students not only transfer knowledge but are engaged and encouraged to be able to discover on their own and relate the information obtained to information already existing in the student's memory (Adijaya *et al.*, 2023). It is supported by the theory of learning constructivism that students' understanding is deeper by involving greater student activities (Schunk, 2020).

One of the mathematics materials that are widely applied in daily life is algebra. Algebra material must be understood and mastered by students to be implemented in daily life and become a prerequisite material for the next material. Based on research Rosita *et al.* (2024) stated that junior high school students have difficulty in understanding algebra concepts due to the lack of direct interaction and active learning between teachers and students and the lack of utilisation of learning approaches.

Therefore, an alternative learning approach is needed to improve mathematical literacy skills in algebraic materials based on real problems. One of the alternatives is to use a learning approach Realistic Mathematic Education (RME). RME is a mathematics learning approach that has the characteristics of discovering mathematical ideas or concepts by students through the real world as a learning benchmark (Ardiniawan *et al.*, 2022). Through the RME approach, students can learn mathematical concepts and ideas from real problems related to daily life (Ferreira, 2020). RME can visualise abstract math concepts into more concrete and easy for students to imagine (Khotimah & Mahmudah, 2021). The advantages of RME include that students find concepts and theories in learning independently, can relate them to daily life, and improve seriousness in learning because all students are actively involved in learning (Wijayanti *et al.*, 2022). RME has also proven to be a pedagogical approach to improve students' mathematical literacy (Putri *et al.*, 2024).

In the RME learning process, student activities are spurred by confidence in their ability to solve real problems so that the desired goals are achieved referred to as self-efficacy. Students with self-efficacy good is significant to mathematical literacy in solving various mathematical problems in daily life (Fatwana *et al.*, 2023).

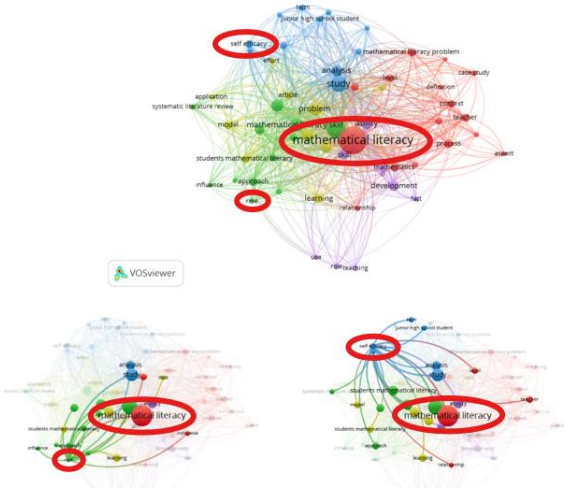


Figure 1. Meta-analysis of research related to mathematical literacy

Figure 1 presents a visualisation of a research network related to mathematical literacy using Viosviewer. The Viosviewer application has facilitated computational mapping related to mathematical problems, providing a comprehensive view of research density and trends (Zahrah *et al.*, 2024). A number of studies have shown a significant relationship between self-efficacy and mathematical literacy. Likewise, research related to RME and mathematical literacy. However, research that specifically examines the application of the RME approach to improve mathematical literacy by considering student self-efficacy factors is still very limited, especially in the context of algebraic material at the junior high school level. The results of the meta-analysis in Figure 1 show a relationship between mathematical literacy and RME and mathematical literacy and self-efficacy, but no connection between the three has been found at the same

time. This condition shows the existence of a research gap, namely the need for a study that integrates the three variables in one research framework. Thus, the novelty of this study lies in the effort to assess mathematical literacy through the RME approach by considering the role of student self-efficacy, especially in algebra learning in junior high school, which has not been done much by previous research. This study aims to identify differences in mathematical literacy skills between students who receive the RME approach and direct learning; identify mathematical literacy abilities based on self-efficacy levels (high, medium, and low); and identify the interaction between learning approaches and self-efficacy on mathematical literacy skills.

II. MATERIALS AND METHOD

This study uses a quantitative type with a quasi-experimental method. In this method, the control class cannot fully control the external variables that are influential in carrying out the experiment (Sugiyono, 2013). The quasi experimental applied was a non-equivalent pretest post-test control group design. The population in this study is all grade VII students of SMP N 1 Sawangan. Samples were taken using cluster random sampling. In the learning process, the experimental class was treated with an RME approach with LKPD media and teaching aids in the form of real context. As for the control class, they get a direct learning treatment with PowerPoint media. The treatment was carried out four times in each class.

Data collection used test instruments in the form of mathematical literacy ability tests and non-tests in the form of self-efficacy questionnaires, observation sheets, interview guidelines and validation questionnaires. Test questions include initial ability tests to measure mathematical literacy skills as problem identification, pretest questions to measure mathematical literacy skills in algebraic materials before being treated, and post-test questions to measure mathematical literacy skills in algebraic materials after being treated. Self-efficacy questionnaires are used to measure students' confidence levels. The observation sheet includes the initial observation sheet to find out the problems in the learning process as the initial data of the research and the learning implementation sheet to see the suitability between the teaching modules prepared and the learning activities. Interview guidelines as a reference in interviews. Validation questionnaires are used to validate instruments by experts.

The self-efficacy indicators used are sourced from the dimensions of level, generality, and strength. The scoring guidelines in the study are described in Table 1, next.

Table 1. Guidelines for scoring questionnaires

Positive statements	Negative statements	Score
Highly suitable	Very inappropriate	4
Appropriate	Inappropriate	3
Inappropriate	Appropriate	2
Very inappropriate	Highly suitable	1

Source: (Hasna *et al.*, 2023)

The scores obtained were then categorised according to the following self-efficacy grouping criteria.

Table 2. Category self-efficacy

Interval	Interprets
$\mathbf{X \geq (M_i + Sb_i)}$	Tall
$\mathbf{(M_i - Sb_i) \leq X < (M_i + Sb_i)}$	Medium
$\mathbf{X < (M_i - Sb_i)}$	low

Information:

X : respondent score

M_i : mean ideal $= \frac{1}{2}$(highest score + lowest score)

Sb_i : Ideal standard deviation $= \frac{1}{6}$(highest score − lowest score)

The data analysis technique is carried out through the initial stage of analysis with the independent sample t-test to determine the balance of students' initial abilities in algebraic material, as well as the final stage with the two-way Anova test and the post-Anova test, namely the Scheffe test. The data analysis process was carried out after the prerequisite tests of normality analysis (Lilliefors test) and homogeneity (Bartlett test) were met.

III. RESULT AND DISCUSSION

The results of the initial stage of analysis with pretest data in the prerequisite test are the normality test to show normal distributed data and the homogeneity test to show that the two classes have the same variant. After the prerequisites are met, an independent sample t-test is carried out which shows the student's initial ability in algebraic material in a balanced state ($-t_{tabel} \leq t_{hitung} \leq t_{tabel}$). The results of the initial data analysis are summarised in Table 3, next.

Table 3. Independent sample t-test test calculation results

Statistics	Experimental Classes	Control Class
Average	53,57	53,63
Standard Deviation	7,29	9,88
Variance	53,15	97,60
S combined	8,7980	
t_{hitung}	-0,0261	
t_{tabel}	2,0003	
Results	H_0 Accepted	

Furthermore, for the final data analysis, post-test data and the results of the self-efficacy questionnaire category were filled with a two-way Anova test. Previously, prerequisite tests had been carried out, namely normality tests and homogeneity tests with the results of each cell being normally distributed and having the same variants. Because it meets the prerequisites, it can be continued with a two-way Anova test using Microsoft Excel. The summary of the Anova test of two different cell paths is presented in Table 4, next.

Table 4. Anova test summary two cell pathways are not the same

Variation	JK	Dk	RK	F_{obs}	F_{tabel}	Results
Learning approach (A)	502,68	1	502,68	4,47	4,01	H_0 rejected
Self-Efficacy (B)	3996,93	2	1998,46	17,78	3,16	H_0 rejected
Interaction (AB)	76,74	2	38,37	0,34	3,16	H_0 Accepted

Because there was a rejection H_0 a post-Anova follow-up test was carried out using the Scheffe test. In the first hypothesis, because there are only two categories of learning approaches, it can be done by comparing the resulting marginal averages presented in Table 5. Meanwhile, to answer the second hypothesis, a Scheffe test was carried out with a comparison of the averages between the columns presented in Table 6.

Table 5. Marginal averages

Learning Approach	Self-Efficacy			Track Margin
	Tall	Medium	Low	
RME	82,00	75,54	63,00	73,51
Immediately	79,00	66,83	56,77	67,53

Table 6. Average comparison results between columns

H_0	F_{obs}	Critical Areas	Results
$\mu_1 = \mu_2$	6,98	$\{F \mid F > 6,32\}$	H_0 rejected
$\mu_2 = \mu_3$	15,09	$\{F \mid F > 6,32\}$	H_0 rejected
$\mu_1 = \mu_3$	34,52	$\{F \mid F > 6,32\}$	H_0 rejected

Results of the two-way Anova test in the first hypothesis Score $F_{obs(A)} = 4,47 > F_a = 4,01$ which means rejecting H_0, thus it can be interpreted that there is an influence of the learning approach on mathematical literacy skills. The marginal average of the RME approach of 73.51 is higher than that of direct learning of 67.53. Thus, it can be concluded that students who get the RME approach have better mathematical literacy skills than students who get direct learning. These findings are supported by the results of a literature review by Taqiya and Juandi (2023) which suggests that learning with the RME approach can improve or affect the improvement of mathematical literacy skills. These

findings are also consistent with Putri *et al.* (2024) that the assimilation of RME learning shows an important and beneficial influence on students' mathematical literacy abilities.

Learning with the RME approach is relevant to math literacy because they both focus on the ability to solve everyday problems. Ultimately, this similarity will provide a way for RME to improve math literacy. The stages in RME also support indicators of mathematical literacy ability.

The first stage is to understand contextual problems to support indicators of communicating problems. In line with Uyen *et al.* (2021) that with the RME approach, students can communicate the ideas they get and the concepts that accompany each stage of learning. The second stage is to explain the contextual problems supporting the mathematisation indicators. Model development is needed as a bridge from concrete knowledge (formal mathematics) to formal knowledge with mathematics (Rusdi *et al.*, 2023). The third stage is to solve contextual problems supporting indicators to design strategies to solve mathematical problems and representations. In line with Nurmasari *et al.* (2024) in this stage students carry out problem-solving steps with the application of facts, procedures, and mathematical reasoning. The fourth stage is to compare and discuss contextual answers, where there is interaction between teachers and students and students so as to support indicators of communicating problems. In line with opinion Uyen *et al.* (2021), that the consequences of interactive learning activities allow for communication, negotiation, explanation, questioning, questioning, and reflection to form formal knowledge. The fifth stage is to conclude that supports the indicators, reinterpret the results accompanied by mathematical arguments. Aligned Nurmasari *et al.* (2024) with that in the concluding stage students can interpret, apply, and evaluate mathematical results to the real world. The last stage is contextual question practice to support all indicators of mathematical literacy. In line with Suryani *et al.* (2024) Providing contextual practice questions can also help students develop the ability to apply the concepts learned in daily life.

Presenting real context in the form of teaching aids in providing contextual problems can increase students' interest and enthusiasm in learning mathematics. Learning documentation with real context is depicted in Figure 2, next.



(a) First Meeting (b) Second Meeting



(a) Third Meeting (b) Fourth Meeting

Figure 2. Learning with real context

In Figure 2(a) namely the First Meeting learning, students were asked to analyse the pattern of calculating the number of sticks used to form a number of parallel squares to learn the sub-chapter of the elements of algebraic forms using props in the form of sticks. Figure 2(b) namely learning in the Second Meeting, students are asked to analyse and draw sketches from pieces of photo frames to learn sub-chapters of properties and operations of algebraic forms using photo frame props and cardboard pieces. Figure 2(c) namely learning in the Third Meeting, students were asked to conduct a simple analysis to determine the ideal growth and development health conditions by taking weight data of several students using digital weight scale props. Figure 2(d) namely learning in the Fourth Meeting, students are asked to analyse the transaction of purchasing goods by someone using a prop of groceries. Contextual problems at the third and fourth meetings were given to study the sub-chapters of mathematical modelling.

Using real context can encourage students to actively show their ideas and skills to solve the given problems. Relevant literature shows the relationship between context and the improvement of students' mathematical literacy skills. Research by Wijaya *et al.* (2021) stated that learning mathematics with realistic problems is effective in improving mathematical literacy. The provision of practice questions also trains students to get used to solving contextual

problems so that they can improve their mathematical literacy skills. This is in line with the opinion Susanta *et al.* (2023) that through activities to do assignments and practice questions, students can develop a mathematical literacy component.

The results of the two-way Anova test in the second hypothesis were obtained a value $F_{obs(A)} = 17,78 > F_a = 3,16$ which means rejected H_0, thus it can be interpreted that self-efficacy has an influence on mathematical literacy skills which results in differences in mathematical literacy skills between students with high, medium, and low self-efficacy. Differences in ability between levels of self-efficacy can occur due to the achievement of different indicators of mathematical literacy ability. The following is presented a diagram of the achievement of indicators of mathematical literacy ability in each category of self-efficacy.

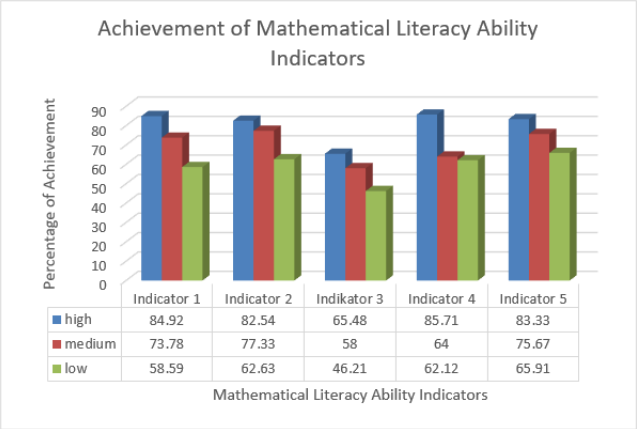


Figure 3. Mathematics literacy ability indicator achievement chart

Based on the post-Anova follow-up test in the Table 6, was obtained a value $F_{1-2} = 6,98$; $F_{2-3} = 15,09$; $F_{1-3} = 34,52$ with a critical area of $DK = \{F|F > 6,32\}$ so that the following conclusions can be drawn,

1) Students with high self-efficacy have better mathematical literacy skills than students who have moderate self-efficacy. Based on the analysis of the achievement of each mathematics literacy indicator, it can be seen that there is a considerable difference between students with high and medium self-efficacy. The difference reached 11.14% for indicator 1 (communicating problems), 5.21% for indicator 2 (mathematical representation), 7.48% for indicator 3 (mathematisation), 21.71% for indicator 4 (designing strategies to solve problems), and 7.66% for indicator 5 (reinterpreting with mathematical arguments). These findings are supported by research results from nisa & arliani (2023) which states that students with high self-efficacy can use mathematical processes optimally at the stage of formulating, using, and interpreting so that they can achieve success in solving the mathematical problems they face.
2) Students with moderate self-efficacy have better mathematical literacy skills than students who have low category self-efficacy. Based on the analysis of the achievement of mathematics literacy indicators, students with medium and low self-efficacy had significant differences in 4 out of 5 mathematics literacy indicators and there was one indicator that had almost the same achievement. The significant difference reached 15.19% for indicator 1 (communicating the problem), 14.7% for indicator 2 (mathematical representation), 11.79% for indicator 3 (mathematisation), and 9.79% for indicator 5 (reinterpreting the results with mathematical arguments). The achievement of almost the same indicator is in indicator 4, namely designing a strategy to solve problems which only has an achievement difference of 1.88%. These results are consistent with the findings Alali & Wardat (2024) which suggests that students with moderate and low self-efficacy do not sufficiently motivate them to learn more about problem-solving strategies that hinder their performance.
3) Students with high self-efficacy have better mathematical literacy skills than students who have low self-efficacy. Based on the analysis of the achievement of the mathematics literacy indicator, it can be seen that there is a significant difference, which reaches 26.33% for indicator 1 (communicating problems), 19.91% for indicator 2 (mathematical representation), 19.27% for indicator 3 (mathematisation), 23.59% for indicator 4 (designing strategies to solve problems), and 17.42% for indicator 5 (reinterpreting results accompanied by mathematical arguments). Students with high self-efficacy can be seen from their confidence to complete the task at hand with confidence and try hard to complete the task. Meanwhile, with low self-efficacy, students tend

to give up easily when faced with difficult tasks and have a lack of enthusiasm or motivation in learning mathematics. In line with Fatwana *et al.* (2023) which states that students who have high self-efficacy are more able to master various math materials and are more enthusiastic in solving various math problems even though they are difficult, compared to students with low self-efficacy.

Results of the two-way Anova test on the third hypothesis Score $F_{obs(A)} = 0{,}34 > F_a = 3{,}16$ which means accepted H_0, thus it can be interpreted that there is no interaction between the learning approach and self-efficacy on mathematical literacy skills. Referring to the research procedures that have been carried out, it is possible that the absence of interaction is caused by several things. First, because the independent variables, namely the learning approach and self-efficacy, have an equally strong impact on mathematical literacy skills. RME exerts a relatively equal influence on all students, regardless of the level of self-efficacy. Likewise, students with higher levels of self-efficacy have higher mathematical literacy skills, regardless of the learning approach used. In line with Zubaidah Amir *et al.* (2021) which states that there is no interaction because the influence of the learning approach on mathematics ability does not depend on the self-efficacy of students and the influence of self-efficacy on mathematical literacy ability does not depend on the learning approach.

Second, the application of the RME learning approach with real context and LKPD is new for students. In addition, previous learning is still rarely carried out learning activities with group discussions. In group discussions, encourage students to work together, respect others, and be more careful in completing tasks (Bella *et al.*, 2024). So that in the experimental class, students are more enthusiastic and enthusiastic about participating in learning, therefore the average value of mathematical literacy ability in each category of self-efficacy that gets the RME approach is always superior compared to direct learning, resulting in non-interaction between variables. This is in line with Nurmasari *et al.* (2024) which suggests that the use of reality context will make the learning atmosphere fun and students become more active.

Third, it is influenced by the learning process, such as the limited hours of teaching and learning activities so that it is less optimal in managing the learning stages. The unpreparedness of students to carry out learning and receive material can be seen when students are not able to express their opinions when given questions and understanding of the material provided by the teacher. Although at the end of the learning it has been conveyed about the topic of the material that will be studied in the next lesson, students have not tried to study the material learned independently. In line with Trisnawati *et al.*, (2023) which revealed that the absence of interaction can be caused by students' unpreparedness for the material being taught so that the mathematical mindset is late in planning a solution strategy.

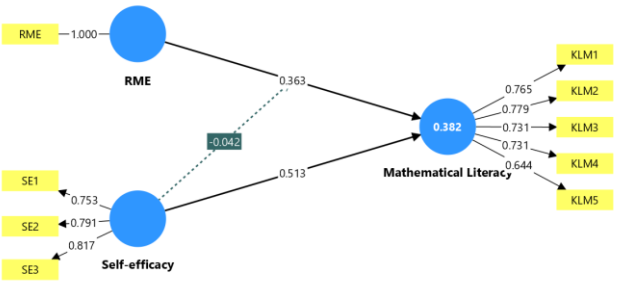


Figure 4. Data Analysis Using Smart PLS

This research was also analysed using Smart PLS contained in Figure 4. It was found that *the RME* approach and *self-efficacy* both affect mathematical literacy ability. The path from RME to math literacy ability has a coefficient of 0.363, indicating a positive influence although not too large. Meanwhile, the path from *self-efficacy* to math literacy ability is 0.513, which means that the influence is positive and quite strong. The *R-square value* in the mathematical literacy ability construct is 0.382, which means that 38.2% of the variation in students' mathematical literacy ability can be explained by RME and *self-efficacy*, while the remaining 61.8% is influenced by other factors outside of this research model.

As for the interaction relationship (moderation) between RME and *self-efficacy* on mathematical literacy ability, a coefficient of -0.042 was obtained. This value shows that the interaction between RME and *self-efficacy* does not make a positive contribution and even tends to weaken the influence of both on mathematical literacy ability. In other words, *self-efficacy* did not significantly moderate the relationship between RME and math literacy ability. This indicates that the influence of RME on mathematical literacy is more independent without being influenced by the level of *student*

self-efficacy. So, there is no interaction between RME and self-efficacy on students' mathematical literacy skills.

The limitations in this study include that there are some students who do not participate in learning in several meetings, the research sample size is limited and not wide, and it is not optimal in managing learning time so that it is not optimal at the learning stage. For the next researcher, it is recommended to be able to ensure the attendance of students at each meeting so that they obtain maximum research results, expand the research subject so that the research results are more tested and more accountable, and pay attention to learning time well so that the learning stages can run optimally.

These findings provide empirical evidence on the effectiveness of RME in improving mathematical literacy. In addition, the results of this study highlight the role of *self-efficacy* as a non-cognitive factor that can be grown to support student learning achievement. Teachers and curriculum developers can leverage these findings to design learning strategies that combine effective teaching approaches with psychological support, thereby improving students' readiness to face real-world math challenges.

IV. CONCLUSION

The mathematical literacy ability of students who get the RME approach is better than students who get direct learning; the mathematical literacy ability of students with high self-efficacy is better than students with medium and low self-efficacy, and the mathematical literacy ability of students with moderate self-efficacy is better than that of students with low self-efficacy; There was no interaction between learning approach and self-efficacy on mathematical literacy ability.

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