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Analysis of Students Mathematical Representation Skills in Relation to Self-Efficacy

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Abstract

Mathematical representation skills and self-efficacy are two important components that interact with one another in determining success in mathematics learning. This study aims to analyze differences in students mathematical representation skills in relation to their levels of self-efficacy, as well as to describe the characteristics of achievement in mathematical representation indicators at each level. The research method used was a mixed-methods approach with an explanatory sequential design. The sample consisted of 29 eighth-grade students from Class VIII I at SMP Negeri 2 Semarang. Data were collected using a self-efficacy questionnaire and a written test of mathematical representation skills, then analyzed using a One-Way ANOVA test and an analysis of students answer sheets. The results of the quantitative analysis indicate significant differences in mathematical representation ability among students with high, medium, and low self-efficacy. Tukey's HSD post hoc test confirms that all pairwise comparisons between groups are statistically significant. Furthermore, the qualitative analysis reveals more complex dynamics through 7 combinations of self-efficacy categories with mathematical representation ability. The relationship between the two variables is not always directly proportional; it was found that students with high self-efficacy had high and medium levels of representational ability, students with medium self-efficacy had high, medium, and low levels of representational ability, and students with low self-efficacy had medium and low levels of representational ability.

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INTRODUCTION

Education is an integral part of human survival and development. In line with Lestari (2019) perspective, education is an absolute necessity whose development must always adapt to the demands of gradual development. Meaningful mathematics learning plays a crucial role, where the primary focus is no longer merely on memorizing formulas, but on a deep understanding of concepts and their application in daily life. Based on Ausubel's theory of meaningful learning, the learning process becomes more meaningful when students can connect new information or knowledge to relevant cognitive structures they already possess (Prayitno et al., 2022). This comprehensive understanding of mathematical concepts serves as an essential foundation, particularly for students in junior high school who are beginning to encounter learning materials with a higher level of abstract complexity.

One indicator of successful understanding of mathematical concepts is students mastery of mathematical representation skills. Based on standards formulated by the National Council of Teachers of Mathematics (NCTM), mathematical representation skills, which encompass visual, symbolic, and verbal aspects, are key components that serve as tools to help students understand abstract concepts, communicate ideas, and solve various mathematical problems (Utami et al., 2020). Mathematical representation is not merely viewed as a product or new construction but also reflects the mental activities and thinking processes that occur when students attempt to organize the mathematical relationships within a problem (Dahlan & Juandi, 2011). Many previous studies have confirmed that this ability is a key determinant of students academic success; consequently, students who struggle with problem representation are likely to fail when faced with complex mathematical problems.

However, this situation has not yet been fully realized in practice. Based on preliminary observations conducted at SMP Negeri 2 Semarang, there are indications that students ability to represent mathematical concepts is still not optimal. When instructed to present their arguments or work, students tend to show significant hesitation. This phenomenon indicates a problem in the students psychological aspect, namely low self-efficacy. The impact of this low self-efficacy is directly evident in the limited forms of representation produced by students when solving word problems; they tend to focus solely on manipulating symbols or numbers without providing logical explanations. In line with the findings of Sufriadin et al. (2022), low self-efficacy is one of the main inhibiting factors in the cognitive process, which ultimately limits students courage and ability to communicate their mathematical ideas effectively.

Several previous studies have examined how students mathematical representation skills are influenced by affective or psychological factors. A study conducted by Sufriadin et al. (2022) revealed that students with high levels of self-efficacy tend to have strong mathematical representation skills because they are more persistent in solving mathematical problems. Meanwhile, Marasabessy (2020) also found that differences in self-efficacy have a significant impact on how students choose forms of representation, with students with high self-efficacy being more flexible in switching from visual to symbolic forms. Nevertheless, research by Septhiani (2022) notes that this relationship is not always perfectly linear for every individual; there are cases where students with medium levels of self-confidence are actually able to produce highly structured mathematical representations, or conversely, students who are overly confident may neglect conceptual accuracy.

Although many studies on mathematical representation skills and self-efficacy have been conducted separately, research that specifically investigates the mapping of mathematical representation skill characteristics analyzed in depth through a combination of students self-efficacy levels still requires further exploration. Based on these limitations, the research questions for this study are: (1) Are there significant differences in students mathematical representation abilities when viewed from the perspective of their self-efficacy levels? and (2) What are the characteristics of students mathematical representation abilities as viewed through the lens of self-efficacy? Therefore, this study aims to describe the mathematical representation abilities of junior high school students in terms of their self-efficacy levels, both through quantitative analysis of differences and qualitative descriptions of the characteristics of visual, symbolic, and verbal indicators.

METHOD

This study employed a mixed-methods approach with a sequential explanatory design. In this study, quantitative data were analyzed first, followed by an in-depth analysis of qualitative data to explain the quantitative results. The population of this study consists of all eighth-grade students at SMP Negeri 2 Semarang for the 2025/2026 academic year. The study sample is Class VIII I, comprising 29 students. The students in this class were then grouped based on categories of self-efficacy and mathematical representation skills for further analysis.

Data collection in this study utilized two types of instruments: a self-efficacy questionnaire and a mathematical representation ability test. The self-efficacy questionnaire was used to measure students levels of self-confidence, which were then categorized as high, medium, or low. The mathematical representation ability test was used to measure students representation skills regarding circle-related material. The test consisted of 3 items, with each item covering the three indicators of mathematical representation ability: visual, symbolic, and verbal representation. Data analysis was conducted in two stages: quantitative data analysis followed by qualitative data analysis. Quantitative analysis was performed on the scores of the mathematical representation ability test. Prerequisite tests, including normality and homogeneity tests, were first conducted on the test result data. After the prerequisite tests were met, a One-Way ANOVA test was conducted to determine whether there were significant differences in students mathematical representation abilities across each self-efficacy category (high, medium, low). If the ANOVA test results indicate a significant difference, the analysis proceeds with Tukey's HSD post-hoc test to determine specific comparisons of mean differences between pairs of groups. Qualitative data analysis was conducted by analyzing students answer sheets. Based on the students answer sheets, the researcher conducted an in-depth analysis of the students work to describe their achievements in mathematical representation skills in terms of self-efficacy

RESULT AND DISCUSSIONS

This study employed a mixed-methods approach with a sequential explanatory design. Data were collected through a mathematical representation ability test and a self-efficacy questionnaire. Quantitative data analysis was performed using a one-way ANOVA to determine whether there were significant differences in students mathematical representation abilities when examined by self-efficacy level (high, medium, and low). The analysis began with the quantitative data, followed by an in-depth analysis of the qualitative data to explain the quantitative results.

Quantitative Results and Discussion

In this study, a quantitative analysis was conducted to determine whether there were significant differences in mathematical representation skills when examined in terms of self-efficacy levels (high, medium, and low). Data collection was carried out by administering a self-efficacy questionnaire. After the questionnaire was administered, the next step was to group the 29 students who had completed the self-efficacy questionnaire into three categories: high, medium, and low. The determination of students self-efficacy levels according to Azwar (2013) is presented in Table 1.

Table 1. Classification of Self-Efficacy

Category	Interval
Low	$X < (\mu - 1{,}0\sigma)$
Medium	$(\mu - 1{,}0\sigma) \le X < (\mu + 1{,}0\sigma)$
High	$X \ge (\mu + 1{,}0\sigma)$

Notes:
X = students self-efficacy scores
μ = mean self-efficacy of students
σ = standard deviation

Based on the results of the self-efficacy questionnaire administered to 29 students, the mean (μ) was 54.61 and the standard deviation (σ) was 9.26. These results were then used to categorize the self-efficacy levels of the 29 students. The results of the self-efficacy categorization for the 29 students are presented in Table 2.

Table 2. Frequency Distribution of Self-Efficacy Categories

Category	Interval	Number of students	Percentage
Low	$X < 56.19$	3	10.34%
Medium	$56.19 \leq X < 88.78$	20	68.97%
High	$X \geq 88.78$	6	20.69%
Total		29	100%

Based on Table 2, it can be concluded that the majority of students fall into the medium self-efficacy category, namely 20 students (68.97%). On the other hand, the group of students with high self-efficacy consists of 6 students (20.69%), while the remaining 3 students (10.34%) have self-efficacy that tends to be weak or falls into the low category.

After the self-efficacy categories of the 29 students were grouped into high, medium, and low categories, the next step was to analyze the mathematical representation ability scores for each of these categories. Grouping the mathematical representation ability test scores was necessary to obtain an initial descriptive overview before conducting a one-way ANOVA. The average scores on the mathematical representation ability test for students based on self-efficacy clusters are presented in detail in Table 3.

Table 3. Average Scores on the Representation Ability Test by Self-Efficacy

Category	Number of students	Mean
Low	3	82.00
Medium	20	71.25
High	6	61.67
Total	29	72.48

Data on students mathematical representation skills were obtained through an essay test consisting of three items, each of which measured three indicators of representation: visual, symbolic, and verbal. Based on empirical data from the research class, the highest student score was 100 and the lowest was 38, with a mean ($\bar{x}$) of 72.48 and a standard deviation (SD) of 16.30. The grouping of mathematical representation ability scores was conducted in the same manner as the grouping of self-efficacy scores, namely divided into three categories (high, medium, low). These results were then used to group the categories of mathematical representation ability among the 29 students. The results of the grouping of mathematical representation ability categories for the 29 students are presented in Table 4.

Table 4. Categories of Representational Ability

Category	Interval	Number of students	Percentage
Low	$X < 56.19$	5	17.24%
Medium	$56.19 \leq X < 88.78$	20	68.97%
High	$X \geq 88.78$	4	13.79%
Total		29	100%

The table provides an overview of the students mathematical representation skills in the study class. The grouping results show that the majority of students mathematical representation skills fall into the medium category, comprising 20 students, or 68.97%. Meanwhile, there were 5 students (17.24%) in the low category, and the highest number of students was in the high category, with only 4 students (13.79%).

Based on the table of average test scores for mathematical representation ability across each self-efficacy category, there appears to be a trend indicating differences in mathematical representation ability that align with students levels of self-efficacy. However, to determine whether these differences are statistically significant, a statistical test using One-Way ANOVA must be conducted. Before performing the ANOVA, prerequisite tests, including the normality test and the homogeneity test, must first be conducted. The normality test aims to determine whether the distribution of mathematical representation ability test scores in each student group follows a normal distribution, thereby ensuring that the data is suitable for analysis using parametric statistics. Meanwhile, the homogeneity test aims to determine whether the variance or level of diversity in the mathematical representation ability data among the three self-efficacy level groups is homogeneous or not.

A normality test aims to determine whether the data obtained comes from a population with a normal distribution (Rosana & Setyawarno, 2016). Data that are normally distributed means the data are centered around the mean and median. If the data come from a population with a normal distribution, then parametric statistical methods are used for hypothesis testing. Conversely, if the data are not normally distributed, hypothesis testing is conducted using nonparametric statistical tests.

This study used the Shapiro-Wilk test due to the relatively small sample size (N < 50), with SPSS used to calculate the normality test. The significance level used was α = 0.05. The hypotheses proposed in this study are as follows.

H_0: (The sample data comes from a population with a normal distribution).

H_1: (The sample data comes from a population that is not normally distributed).

The criteria for accepting or rejecting the hypothesis, based on the hypothesis that has been proposed, are as follows: accept H_0 if the $sig >$ 0,05 and reject H_0 if the $sig <$ 0,05. The results of the normality test for the mathematical representation ability data, conducted using SPSS, are presented in Table 5.

Table 5. Summary of the Normality Test

Category of *Self-efficacy*	df	$sig.$	Conclusion
High	6	0.165	Normally distributed
Medium	20	0.310	Normally distributed
Low	3	0.915	Normally distributed

Based on the results of the normality test in Table 5, it was found that the significance value (sig.) in the Shapiro-Wilk column for the high self-efficacy group was0.165 > 0.05, for the medium group was, and for the 0.310 > 0.05 low group was0.915 > 0.05. Since all significance values were consistently greater than the set significance level of 0.05, H_0 is accepted. Based on this, it can be concluded that the data on students mathematical representation ability test scores across the three self-efficacy levels (high, medium, low) are normally distributed.

Once the assumption of normality is met, the next step is the homogeneity test. The homogeneity test is conducted to ensure that the sample data groups come from a homogeneous population or have equal variances (Rosana & Setyawarno, 2016). In this study, the homogeneity test used Levene's test with the assistance of SPSS software. The significance level used was α = 0.05. The hypotheses proposed in this study are as follows.

$H_0: \sigma_1^2 = \sigma_2^2$ (the sample has homogeneous variance).

$H_1: \sigma_1^2 \neq \sigma_2^2$ (the sample has non-homogeneous variance).

Based on this hypothesis, the acceptance criteria are as follows: accept H_0 if the sig > 0,05 and reject H_0 if the sig < 0,05. The results of the homogeneity test for the mathematical representation ability test data are presented in Table 6.

Table 6. Summary of the Homogeneity Test

Statistic	$df1$	$df2$	$sig.$	Conclusion
0.379	2	26	0.688	Homogeneous Variancen

Based on the results of the homogeneity test in the table, a significance value of 0.688 > 0.05 was obtained; therefore, H_0 is accepted. Based on this, it can be concluded that the mathematical representation ability test scores across the three self-efficacy groups have equal or uniform (homogeneous) variances. Since the prerequisites, including the normality and homogeneity tests, have been met, the analysis can proceed to hypothesis testing using a One-Way ANOVA.

An ANOVA test was conducted to determine whether there were significant differences in students mathematical representation skills based on their self-efficacy categories. The significance level used in this test was α = 0.05. The hypotheses proposed in this study are as follows.

$H_0: \mu_1 = \mu_2 = \mu_3$ (There were no significant differences in students mathematical representation skills across the three levels of self-efficacy).

H_1: (There are significant differences in students mathematical representation skills across the three levels of self-efficacy).

ased on this hypothesis, the acceptance criterion is as follows: accept H_0 if the $sig > 0{,}05$ indicating that there is no significant difference in students mathematical representation skills across the three levels of self-efficacy. Otherwise, H_0 is rejected, indicating that there is a significant difference in students mathematical representation skills across the three levels of self-efficacy. The results of the One-Way ANOVA test of mathematical representation ability data using SPSS are presented in Figure 1.

ANOVA

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	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2877.191	2	1438.596	8.202	.002
Within Groups	4560.050	26	175.387		
Total	7437.241	28			

Figure 1. Result of the One-Way ANOVA Test

Based on the results of the one-way ANOVA in the table, the F-statistic was found to be $F = 8{,}202$ with a significance level (sig.) of 0.002. Since this significance level is smaller than the predetermined significance level ($0.002 < 0.05$), H_0 is rejected and H_1 is accepted. Based on this, it can be concluded that there is a significant difference in students mathematical representation ability among the three levels of self-efficacy (high, medium, low).

After the one-way ANOVA test indicated a significant overall difference, the next step was to conduct a post hoc test using Tukey's HSD (Honestly Significant Difference) method. This post hoc test was conducted to specifically identify which pairs of self-efficacy level groups exhibited significant differences in the mean mathematical representation ability. The significance level used was $\alpha = 0.05$. The hypotheses proposed are as follows.

1) Comparison of the High Self-Efficacy Group with the Medium Self-Efficacy Group

   $H_0: \mu_1 = \mu_2$ (There was no significant difference in the mean mathematical representation ability between students with high and medium self-efficacy).

   $H_1: \mu_1 \neq \mu_2$ (There is a significant difference in the average level of mathematical representation ability between students with high and medium self-efficacy).

2) Comparison of the High-Self-Efficacy Group with the Low-Self-Efficacy Group

   $H_0: \mu_1 = \mu_3$ (There was no significant difference in the mean mathematical representation ability between students with high and low self-efficacy).

   $H_1: \mu_1 \neq \mu_3$ (There is a significant difference in the average level of mathematical representation ability between students with high and low self-efficacy).

3) Comparison of the Medium-Self-Efficacy Group with the Low-Self-Efficacy Group

   $H_0: \mu_2 = \mu_3$ (There was no significant difference in the mean mathematical representation ability between students with medium and low self-efficacy).

   $H_1: \mu_2 \neq \mu_3$ (There is a significant difference in the average level of mathematical representation ability between students with medium and low self-efficacy).

Based on this hypothesis, the acceptance criterion for the hypothesis is to accept H_0 if the $sig > 0{,}05$ This means that there were no significant differences in students mathematical representation skills among the tested pairs of self-efficacy levels. In other respects, H_0 was rejected, indicating that there was a significant difference in students mathematical representation skills among the tested pairs of self-efficacy levels.

A detailed comparison of the mean scores for mathematical representation skills between pairs of self-efficacy groups is presented as follows:

1) High Self-Efficacy Group vs. Medium Self-Efficacy Group

   Based on the results of further analysis, a summary of the comparison of mean scores for mathematical representation skills between students with high and medium self-efficacy is presented in Table 7.

Table 7. Results of the Post-hoc Test for the High vs. Medium Self-Efficacy Groups

Group Pair	Mean Difference	$sig.$	Conclusion
High vs Medium	16.683	0.031	H_0 rejected

Based on Table 7, it can be concluded that there is a significant difference in mathematical representation ability between students in the high self-efficacy group and those in the medium self-efficacy group. Students in the high self-efficacy group had a higher average score of 16.683 compared to students in the medium self-efficacy group.

2) High Self-Efficacy Group vs. Low Self-Efficacy Group
Based on the results of further analysis, a summary comparing the average scores for mathematical representation skills between students with high and low self-efficacy is presented in Table 8.

Table 8. Results of the Post-hoc Test for the High vs. Low Self-Efficacy Groups

Group Pair	Mean Difference	$sig.$	Conclusion
High vs Low	37.167	0.001	H_0 rejected

Based on Table 8, it can be concluded that there is a significant difference in mathematical representation skills between students in the high self-efficacy group and those in the low self-efficacy group. Students in the high self-efficacy group had a higher average score of 37.167 compared to students in the low self-efficacy group.

3) Medium Self-Efficacy Group vs. Low Self-Efficacy Group
Based on the results of further analysis, a summary comparing the average mathematical representation ability scores between students with high and medium self-efficacy is presented in Table 9.

Table 9. Results of Further Tests

Group Pair	Mean Difference	$sig.$	Conclusion
Medium vs Low	20.483	0.049	H_0 rejected

Based on Table 9, it can be concluded that there is a significant difference in mathematical representation ability between students in the medium self-efficacy group and those in the low self-efficacy group. Students in the medium self-efficacy group had a higher average score of 20.483 compared to students in the low self-efficacy group.

To clearly illustrate how students are distributed based on the combination of their self-efficacy levels and cognitive abilities, a mapping of the number of students based on these two variables is presented in Table 10.

Table 10. Distribution of Representation Skills Based on Self-Efficacy

SE Category	Representation Ability Category			Total
	High	Medium	Low	
High	2	4	0	6
Medium	2	15	3	20
ow	0	1	2	3
Total	4	20	5	29

Table 10 shows that students levels of self-efficacy do not always correlate directly with their mathematical representation skills. In the group of students with high self-efficacy, consisting of 6 students, only 2 students had high mathematical representation skills, while the other 4 students were in the medium category. This situation occurs when students feel very confident and capable of solving mathematical problems, but in reality, their test results indicate that their skills are still at a medium level.

The group of students with medium self-efficacy, consisting of 20 students, had the most diverse range of abilities. They were distributed across all levels of representational ability: 2 students in the high category, 15 in the medium category, and 3 in the low category. These students were actually capable of solving math problems, but they lacked confidence in their own abilities.
Meanwhile, in the group of students with low self-efficacy—consisting of three students—the majority demonstrated low representational ability (two students), while only one student achieved the medium category. The fact that no students from the low self-efficacy group achieved high representational ability reinforces the assumption that low self-confidence is directly proportional to the emergence of barriers that prevent students

from fully developing mathematical representation ideas.

Qualitative Results and Discussion

Qualitative analysis was used to explore the characteristics of students thinking processes for each combination of the categories above; this analysis was conducted descriptively based on patterns in students test responses. The following table 11 shows the combinations of self-efficacy categories and students mathematical representation skills.

Table 11. Combinations of Self-Efficacy Categories and Representation Ability

Self-Efficacy Category	Representation Ability Category
High	High
	Medium
Medium	High
	Medium
	Low
Low	Medium
	Low

Based on these seven combinations, a qualitative analysis was conducted to determine how students thinking processes led to the generation of various ideas for mathematical representations. The descriptive qualitative analysis for each group combination is presented as follows.

Students in the high self-efficacy group demonstrated mathematical representation skills in the high and medium categories. Students with high self-efficacy and high mathematical representation skills showed excellent performance on all indicators. For the visual representation indicator, students were able to create complete sketches with captions consistent with the information provided in the questions. For the symbolic representation indicator, students were able to write mathematical models, select the appropriate formulas, and apply them with correct calculations. Meanwhile, for the verbal representation indicator, students were able to write answers accompanied by logical reasoning using their own words.

Students with high self-efficacy and medium mathematical representation skills demonstrated fairly good performance but faced challenges in certain aspects of accuracy. Regarding the visual representation indicator, students were able to create complete sketches with captions consistent with the information provided in the questions. However, regarding the symbolic representation indicator, students struggled to write out mathematical models in full and made errors in the calculation process, which ultimately placed their scores in the medium category. Meanwhile, regarding the verbal representation indicator, students are still able to write their answer conclusions with logical reasoning using their own words. High self-efficacy is the primary determinant of students success in mastering all types of mathematical representations (Kartini et al., 2025). Students in this group are not only proficient in technical aspects such as calculating formulas (symbolic) or drawing sketches (visual). They also possess mature literacy skills, enabling them to explain the reasoning behind their answers with very clear words (verbal) for each question

Students with medium self-efficacy and mathematical representation skills fall into the most diverse category, namely high, medium, and low. Students with medium self-efficacy and high mathematical representation skills demonstrate excellent performance on every indicator. In this group, although students self-efficacy scores fall into the medium category, their mathematical representation skills reach the high category. For the visual representation indicator, students were able to create complete sketches with captions consistent with the information provided in the question. For the symbolic representation indicator, students were able to write out complete mathematical models, select the correct formula, and apply it with accurate calculations. Meanwhile, for the verbal representation indicator, students were able to write answers accompanied by logical reasoning using their own sentences.

Students with medium self-efficacy and medium mathematical representation skills demonstrated fairly good performance on the visual and symbolic indicators but fell short on the verbal representation indicator. For the visual representation indicator, students were able to create complete sketches with captions consistent with the information provided in the problem. For the symbolic representation indicator, students could write mathematical models, select the appropriate formulas, and apply them with correct calculations. Meanwhile, on the verbal representation indicator, students underperformed because they tended to directly write down the final result as a number without providing an explanation or logical reasoning in their own words. This aligns with the research by Sari et al. (2025) on the relationship between students attitudes and thinking skills. They were able to demonstrate proficiency in visual and symbolic representation. In fact, when they maximize their mastery and understanding of the concepts they possess, they are also able to provide reasons for their answers using their own words.

Students with medium self-efficacy and low mathematical representation skills demonstrated suboptimal performance and struggled with the symbolic and verbal representation indicators. Regarding the visual representation indicator, students were still able to create the sketches requested in the questions, even though the instructions provided were incomplete. However, regarding the symbolic representation indicator, students struggled to write mathematical models, selected formulas inappropriately, and made errors in the calculation process. Meanwhile, regarding the verbal representation indicator, students also struggled, making them unable to write down the conclusion of the answer or provide logical reasoning using their own words.

Students with low self-efficacy demonstrated mathematical representation skills in the medium and low categories. In this group, although their self-efficacy levels fall into the low category, their mathematical representation skills are classified as medium. Students with low self-efficacy and medium mathematical representation skills demonstrate fairly good performance on certain indicators, despite being accompanied by a high level of self-doubt. On the visual representation indicator, students are still able to create sketches with sufficiently clear labels consistent with the information provided in the problem. For the symbolic representation indicator, students were also able to write mathematical models and use formulas with correct calculations. However, for the verbal representation indicator, students were less able to meet the criteria because they could not write answers accompanied by logical explanations or reasons using their own words, which ultimately placed their representation scores in the medium category.

Students with low self-efficacy and low mathematical representation skills demonstrated an inability to meet most of the indicators of mathematical representation skills. Regarding the visual representation indicator, students were unable to create sketches or illustrations of what was known in the problem. For the symbolic representation indicator, students also experienced significant difficulty, making them unable to write down mathematical models, identify which formulas to use, or outline the calculation process. Meanwhile, for the verbal representation indicator, students were completely unable to write down answers or provide logical reasoning using their own words, resulting in some answer sheets in this group being left blank.

CONCLUSION

Based on the results of the study and the discussion regarding the analysis of students mathematical representation abilities in relation to self-efficacy, the following conclusions were drawn. There is a significant difference in mathematical representation abilities among students with high, medium, and low self-efficacy. This is demonstrated by the results of the One-Way ANOVA statistical test, which showed an F-value of 8.202 with a significance level (sig.) of 0.002. This indicates that the significance level is smaller than the predetermined significance level ($0.002 < 0.05$). Based on this, it can be concluded that there is a significant difference in students mathematical representation skills among the three levels of self-efficacy (high, medium, low). The results of the post-hoc tests reinforce the finding that all pairs of self-efficacy groups exhibit significant differences in mathematical representation skills. The largest difference occurred between the high and low self-efficacy groups, as indicated by a mean difference of 37.167. The next significant difference occurred between the medium and low self-efficacy groups, as indicated by a mean difference of 20.483. Meanwhile, the high and medium self-efficacy groups showed a significant difference with a mean difference of 16.683.

The results of the qualitative analysis indicate that there are seven combinations of self-efficacy categories and students mathematical representation ability categories. The relationship between self-efficacy and mathematical representation ability is not always directly proportional. The research results show that the high self-efficacy group is divided into two combinations of mathematical representation ability levels, namely high and medium. The combination of high self-efficacy and medium mathematical representation ability shows optimal achievement on all three indicators. Meanwhile, the combination of high self-efficacy and medium mathematical representation ability shows less than optimal achievement in meeting the symbolic and calculation error indicators.

The medium self-efficacy group was divided into three combinations of mathematical representation skills: high, medium, and low. The combination of medium self-efficacy and high mathematical representation skills showed excellent performance on all indicators. The combination of medium self-efficacy and medium mathematical representation ability shows fairly good performance in the visual and symbolic aspects, but falls short in achieving the verbal representation indicator. Meanwhile, the combination of medium self-efficacy and low mathematical representation ability shows difficulties in the verbal and symbolic indicators.

The low self-efficacy group is divided into two combinations of mathematical representation ability: medium and low. The combination of low self-efficacy and medium mathematical representation ability showed fairly good performance on basic visual and symbolic indicators but was less able to meet the verbal indicators. Meanwhile, the combination of low self-efficacy and low mathematical representation ability demonstrated an inability to meet most indicators, resulting in the majority of answer sheets being left blank.

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