# Exploring the impact of self-confidence on students' mathematical representation skills

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## Abstract

This study investigates the influence of self-confidence on students' mathematical representation abilities, which are essential for interpreting and communicating mathematical ideas. Employing a comparative correlational design, the research involved eighth-grade students selected through a cluster random sampling method. The data were obtained using a self-confidence questionnaire and a mathematical representation test, both of which were validated for reliability and content relevance. Data analysis was conducted using statistical techniques to examine differences in students' representation skills based on their self-confidence levels. The findings reveal that students with higher self-confidence tend to demonstrate stronger abilities in representing mathematical concepts compared to those with moderate or low self-confidence. These students are more inclined to engage in problem-solving processes, utilize multiple forms of representation, and articulate their reasoning more effectively. The results support the idea that self-confidence plays a critical role in facilitating not only motivation and engagement but also cognitive performance in mathematics. This study underscores the importance of integrating strategies that nurture self-confidence within mathematics instruction. By doing so, educators can enhance students' abilities to represent, interpret, and apply mathematical knowledge in meaningful ways. Encouraging a positive learning environment that values effort and supports student confidence may significantly contribute to overall mathematical proficiency.

**Keywords**: Mathematical education, Mathematics representation, Self-confidence, Students' skills

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## INTRODUCTION

The ability to effectively represent mathematical ideas is one of the essential skills in mathematics education (Rahayu & Zakiah, 2018; Terwel et al., 2009; Urban et al., 2017). This skill plays a crucial role in helping students understand abstract concepts that are often hard to grasp when explained only verbally or in writing. By using visual representations like graphs, diagrams, tables, or equations, students can turn abstract information into more concrete and understandable forms (An et al., 2023; Ηλία et al., 2007). This process not only makes understanding easier but also helps students see connections between different mathematical concepts that may not have been clear before. Additionally, effective representation allows students to communicate their understanding more clearly and in an organized way, whether to teachers or peers. This skill also strengthens students' ability to solve complex math problems, as they can consider solutions from various perspectives. Therefore, developing mathematical representation skills is a key focus in mathematics education, ensuring that students can master and

apply the concepts they learn effectively.

However, even though these skills are very important, many students struggle significantly to develop them. Difficulties in accurately representing mathematical concepts often become a major barrier to solving math problems (Hecht & Vagi, 2010; Shin & Bryant, 2015). Factors like a lack of basic understanding of the concepts being taught and ineffective teaching methods can make this situation worse. Additionally, students often don't get enough opportunities to practice mathematical representation during the learning process, which can further slowdown their skill development. Without sufficient practice, students may lose confidence in using different forms of representation and might avoid tasks that involve complex representations. When students cannot accurately represent concepts, they also find it hard to connect what they learn with real-world applications (Matabane & Machaba, 2023). This can eventually hinder their academic progress and reduce their interest in mathematics. Therefore, it is crucial for educators to recognize and address these challenges to help students build strong representation skills.

To address these challenges, educators have been exploring strategies to help students develop their mathematical representation skills. One approach that has gained increasing attention is the role of psychological factors, particularly self-confidence, in influencing students' abilities to represent mathematical ideas (Gunawan & Muflihati, 2022; Hermaitriyana & Samsir, 2021; Setiawan et al., 2022). High self-confidence allows for a greater willingness to try different ways of representing concepts and believe in their own ability to solve problems. On the other hand, students who have low self-confidence are feared to hesitate and avoid challenges related to mathematical representations which ultimately hinder the development of their skills (Hermaitriyana & Samsir, 2021). By caring about students' self-confidence, it is hoped that teachers can help them become more active and involved in the learning process, especially in developing their representation skills. In addition, by paying attention to students' self-confidence, teachers are also expected to be able to create teaching strategies that include positive feedback and opportunities to practice representation in a good environment. Therefore, understanding students' self-confidence is very important in improving their mathematical representation skills, which in turn will improve the quality of mathematics education as a whole.

Given the important role of self-confidence in mathematics education, several studies have explored its impact on various learning outcomes, highlighting the need for further research on its influence on mathematical representation skills. For example, studies by Djakaria & Ilham (2022) and Oktarisa et al. (2024) have shown that self-confidence plays an important role in improving students' mathematics learning outcomes. In addition, Byiringiro (2024) and Kunhertanti & Santosa (2018) found that self-confidence positively affects students' performance in mathematics. Other studies have also shown the influence of self-confidence on various aspects of mathematical thinking, such as problem solving (Fitayanti et al., 2022; Puspalita et al., 2022), critical thinking (Melyana & Pujiastuti, 2020), mathematical reasoning (Faudziah & Kadarisma, 2019), and mathematical connections (Malinda & Minarti, 2018), indicating that self-confidence can strengthen students' mathematical skills, which are very important in mathematics education. However, despite the abundance of research, little to no research has specifically explored how self-confidence influences students' mathematical representation skills in the context of mathematics learning. Therefore, the purpose of this study is to fill this gap by investigating the influence of self-confidence on students' mathematical representation skills in mathematics education. This study aims to provide deeper insights into the role of self- confidence in enhancing this important skill, which is critical to students' success in learning mathematics.

## METHODS

This study employed a comparative correlational design to investigate the relationship and differences between students' self-confidence and their mathematical representation abilities. The design was selected because it allows researchers to observe natural variations between groups without implementing experimental treatments, making it appropriate for real classroom contexts. Comparative correlational studies are effective for identifying potential predictive relationships between psychological attributes and academic skills. This approach is particularly useful when ethical or logistical considerations make experimental manipulation difficult. By focusing on naturally occurring differences in self-confidence, the study aims to provide insights that can be applied in practical educational settings.

The population of this study consisted of eighth-grade students at SMP Negeri 1 Martapura. A cluster random sampling technique was employed to ensure representativeness while maintaining practicality in a school environment. Two classes were randomly selected from the school's eighth-grade cohort, with a total of 52 students participating in the research. These two classes were chosen based on similarities in instructional conditions, such as being taught by the same mathematics teacher and following the same syllabus, which helped to control external variables. The similarity of instructional context strengthened the internal validity of the findings by reducing instructional bias.

Two primary instruments were used in data collection: a self-confidence questionnaire and a mathematical representation test. The self-confidence questionnaire was developed by adapting items from previously validated scales and consisted of 20 statements rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire covered emotional, cognitive, and behavioral dimensions of self-confidence in mathematics learning. For instance, one of the items stated, "I feel confident when solving complex math problems." The instrument underwent content validation by two education experts and construct validation using Exploratory Factor Analysis (EFA) with SPSS version 25. The reliability coefficient (Cronbach's Alpha) of 0.87 demonstrated high internal consistency.

The mathematical representation test was constructed to assess students' ability to use various forms of representation, such as symbolic, graphical, and verbal formats, in solving mathematical problems. The items were designed based on the core competencies of mathematics representation and were validated through expert review. Each test item underwent analysis for difficulty index, discrimination index, and reliability, ensuring that the instrument was psychometrically sound. An example of a test item asked students to convert a contextual problem into an algebraic model and illustrate it graphically. The test was administered after the completion of instructional sessions to ensure that students had been exposed to the relevant material.

The research procedure was carried out in several stages. On the first day, students completed the self-confidence questionnaire under the supervision of their classroom teacher and the researchers to ensure a standardized administration. The following day, students took the mathematical representation test in a controlled classroom setting. The separation of test sessions was intended to minimize cognitive fatigue and response bias. Both instruments were administered in written format and collected immediately after completion to prevent external influences. Ethical guidelines were observed throughout the process, and students were informed about the purpose and confidentiality of their participation. The following flowchart presents a visual overview of the research procedures applied in this study (see Figure 1).

Prior to hypothesis testing, preliminary analyses were conducted to check for normality and homogeneity of variance. The Shapiro-Wilk test was used to assess normal distribution, and Levene's

test was used to examine the equality of variances among groups. The results indicated that all assumptions for One-Way ANOVA were met. Subsequently, One-Way ANOVA was conducted to analyze whether there were significant differences in students' mathematical representation abilities across low, medium, and high self-confidence groups. All analyses were carried out at a significance level of 0.05 using SPSS, ensuring the statistical rigor of the study.

To ensure ethical compliance, informed consent was obtained from all student participants and their parents or guardians. The study was conducted in collaboration with the school administration and received official permission to proceed. All students participated voluntarily and were assured that their responses would be kept confidential and used solely for research purposes. The research adhered to ethical standards for educational research involving minors. These precautions ensured that the study maintained its integrity while protecting the rights and welfare of participants.

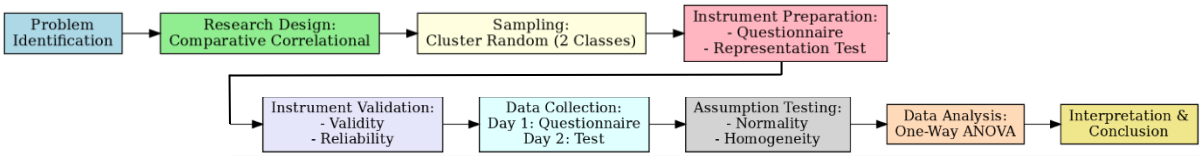


**Figure 1.** Research Procedure Flowchart

## RESULTS AND DISCUSSION

### Normality Test

To determine whether the data were appropriate for parametric analysis, a Shapiro-Wilk test was conducted to examine the normality of mathematical representation scores across the three self-confidence groups. The test yielded p-values of 0.256 for the low group, 0.452 for the medium group, and 0.817 for the high group—all exceeding the 0.05 significance level. These results indicate that the data were normally distributed within each group, thereby satisfying one of the primary assumptions for conducting ANOVA.

### Homogeneity of Variance Test

Levene's test was performed to verify the assumption of equal variance across groups. The test results based on mean ($p = 0.519$), median ($p = 0.517$), median with adjusted degrees of freedom ($p = 0.518$), and trimmed mean ($p = 0.518$) all showed non-significant results, confirming that the assumption of homogeneity of variance was met. Thus, the data were suitable for comparison using a one-way ANOVA test.

### One-Way ANOVA Test

The one-way ANOVA analysis revealed a statistically significant effect of self-confidence on students' mathematical representation abilities ($F(2,49) = 356.359$, $p < 0.001$). This suggests that the level of self-confidence contributes meaningfully to differences in students' performance in representing mathematical ideas. Table 1 presents the full results of the analysis of variance.

**Table 1**. One Way Anova Results

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 3697.541 | 2 | 1848.770 | 356.359 | .000 |
| Within Groups | 254.209 | 49 | 5.188 | | |
| Total | 3951.750 | 51 | | | |

The results demonstrated a clear trend across the three groups. Students in the high self-confidence group achieved the highest mean score (M = 80.56, SD = 3.27), followed by those in the medium self-confidence group (M = 71.12, SD = 2.98), and finally the low self-confidence group (M = 60.00, SD = 3.10). The increasing pattern in scores indicates that self-confidence not only correlates with but may also facilitate the development of more advanced representation skills. To visualize the differences, Figure 2 shows the mean mathematical representation scores across self-confidence levels.

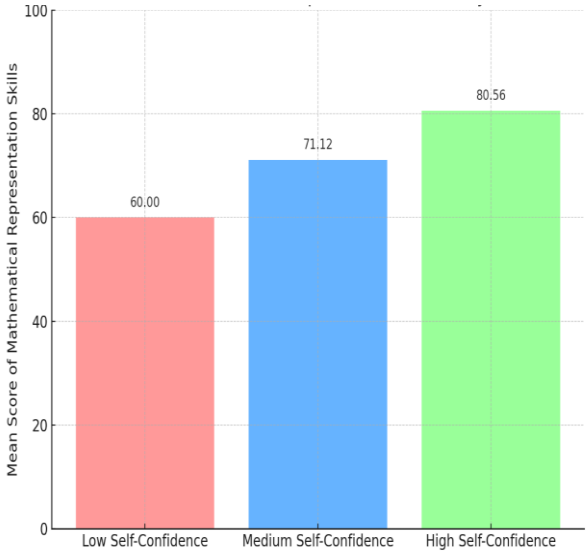


**Figure 2.** Mean Scores of Mathematical Representation Skills by Self-Confidence Group

These findings suggest that students with higher levels of self-confidence are more capable of using diverse forms of mathematical representation. They tend to perform better when required to convert verbal problems into equations, interpret data visually, or explain symbolic patterns. On the contrary, students with lower self-confidence may experience hesitation or reduced persistence in solving tasks that require abstract or symbolic translation, which is essential in mathematics learning.

In summary, the statistical analysis indicates that self-confidence significantly affects students' ability to represent mathematical ideas. This supports the theoretical framework that psychological factors, such as belief in one's competence, play a crucial role in cognitive performance. The implications of this result will be further elaborated in the next section.

These results demonstrate that self-confidence significantly influences students' mathematical representation abilities. Students who possess higher levels of self-confidence are more capable of translating mathematical ideas into various representational forms such as symbols, diagrams, or verbal expressions. This suggests that confidence is not just a motivational factor, but also contributes to how students cognitively process and internalize mathematical content. The ability to represent mathematics effectively is tied to students' belief in their own skills, which motivates them to persist through complex tasks. This aligns with Bandura's (2023) concept of self-efficacy, which posits that individuals with high confidence in their abilities are more likely to approach challenging tasks as opportunities rather than threats. In the context of mathematics, where abstraction is prevalent, this mindset can be particularly advantageous (Boaler, 2022). Self-confident students are more likely to engage in meaningful mathematical activities, make connections, and test hypotheses (Alcantara, 2020). Therefore, enhancing self-confidence may be a crucial factor in improving students' mathematical representation abilities, especially in topics that demand higher-order thinking.

The results of this study confirm that there are significant differences in students' mathematical representation abilities based on their self-confidence levels. The ANOVA test produced an F-value of 356.359 and a p-value of 0.000, indicating a highly significant difference between groups. Students with high self-confidence achieved the highest mean score (80.56), followed by medium (71.12) and low self-confidence students (60.00). This gradient clearly illustrates a positive trend between self-confidence and representational competence. These findings are consistent with previous studies that have reported similar results across other areas of mathematics learning. For example, Fitayanti et al. (2022) and Puspalita et al. (2022) demonstrated that self-confidence improves mathematical problem-solving abilities. Additionally, Melyana & Pujiastuti (2020) and Faudziah & Kadarisma (2019) found that self-confidence contributes to students' critical thinking and mathematical reasoning. These consistent results strengthen the assertion that self-confidence is not only influential in general learning performance but specifically vital in developing key mathematical skills. In this way, self-confidence becomes a foundational construct that underpins various aspects of mathematical cognition.

However, this study also offers new insights by specifically examining how self-confidence affects students' mathematical representation abilities, a dimension that has received less attention in prior research (Ahmad et al., 2023; Hendriana et al., 2018; Siregar et al., 2020; Wahyuni et al., 2024). While many earlier studies have explored the role of self-confidence in problem-solving, logical reasoning, or conceptual understanding, few have directly addressed its impact on students' abilities to translate mathematical ideas into different forms. The present findings suggest that self-confidence enhances students' willingness and capacity to represent abstract concepts through visual, symbolic, or textual means (Bernard & Senjayawati, 2019; Fay et al., 2022). This ability is critical because representation acts as a bridge between mathematical thinking and external communication (Coles & Sinclair, 2019; Goldin, 2020). Therefore, this study adds an important dimension to the literature by linking affective characteristics with specific cognitive outputs such as mathematical representation. It confirms that self-confidence does not work in isolation but actively facilitates how students organize and externalize mathematical information. Understanding this dynamic helps educators tailor strategies that support both emotional and intellectual development in mathematics classrooms.

Furthermore, these results underscore the importance of fostering students' self-confidence as a strategic pathway to enhance mathematical representation skills. The findings affirm that self-confidence is closely linked to success in mathematics learning, including competencies that are often underemphasized such as symbolic modeling and diagrammatic reasoning. Boosting self-confidence may particularly help students who experience anxiety or reluctance in engaging with non-routine tasks. As supported by Soares et al. (2020), emotionally secure learning environments are more likely to produce confident students who perform better in conceptual understanding. Therefore, classroom practices should be intentionally structured to include confidence-building activities such as scaffolding, peer support, and continuous positive feedback. These approaches create a culture of resilience, where students view challenges as part of the learning process rather than as threats to self-esteem*. In this regard, integrating self-confidence development into the mathematics curriculum is not optional, but essential. As mathematical representation forms the basis of problem-solving and abstraction, the role of confidence becomes central to academic success in mathematics.

This study also highlights the necessity for future research to delve deeper into the interaction between psychological variables and mathematical thinking. Although this study confirms a strong link between self-confidence and representation, the influence of other affective factors "such as self-regulation, motivation, or mindset" should not be overlooked. Longitudinal studies may offer insights into

how self-confidence evolves and impacts mathematical competencies over time. In addition, qualitative research such as classroom observation or student interviews could explore the nuances behind why certain students are more confident in representational tasks than others. It would also be beneficial to examine how different teaching styles affect the development of both confidence and representational skills. For instance, constructivist learning environments may offer more opportunities for student expression and ownership, which in turn strengthens both affective and cognitive domains*. These directions will not only enrich theoretical understanding but also inform the development of more inclusive and psychologically attuned instructional models in mathematics education.

In summary, this study validates the significant role of self-confidence in enhancing students' mathematical representation skills and extends previous research by explicitly focusing on this underexplored cognitive dimension. The results show that students with high levels of self-confidence are better equipped to express mathematical ideas across various representational modes. This confirms that affective characteristics can serve as predictors and enablers of academic success, especially in disciplines that require abstract reasoning like mathematics. Educators and curriculum developers should therefore consider self-confidence not as a supplementary trait, but as a core component of mathematics instruction. Strategies that promote a growth mindset, reduce math anxiety, and encourage active participation will likely enhance students' confidence and, in turn, their representational skills*. As mathematics education evolves to meet the demands of 21st-century skills, focusing on the integration of emotional and cognitive development becomes increasingly necessary. Ultimately, fostering students' self-confidence is a long-term investment in their mathematical competence and overall academic growth.

Beyond reinforcing existing theories, this study presents meaningful contributions to the field of mathematics education. Theoretically, it extends the understanding of affective-cognitive dynamics by highlighting how self-confidence specifically shapes students' abilities to construct and convey mathematical ideas through various forms of representation. This linkage has rarely been emphasized in previous research. From a practical standpoint, the study offers actionable insights for mathematics educators—emphasizing the value of nurturing confidence alongside content mastery to improve student performance in representational tasks. Methodologically, the research demonstrates a replicable model using validated instruments and robust statistical procedures to explore psychological influences on learning outcomes. These contributions support a more integrated view of mathematics education that considers not only students' cognitive readiness but also their emotional preparedness. As educational goals increasingly demand 21st-century competencies like metacognition, visual reasoning, and problem representation, studies like this provide essential evidence for refining both pedagogy and assessment. Thus, by addressing an underrepresented link between self-confidence and mathematical representation, this study adds depth to existing literature and serves as a foundation for future educational innovations.

## CONCLUSION

Based on the results of this study, it can be concluded that self-confidence has a significant influence on students' mathematical representation abilities. Students with high levels of self-confidence demonstrated better representation skills compared to those with medium and low self-confidence. There were significant differences between the groups, showing that self-confidence is an important factor in mathematics learning. In addition to supporting previous research on the role of self-confidence in problem-solving and mathematical reasoning, this study also provides new insights into how self-confidence affects mathematical representation. Therefore, developing self-confidence among students

should be a key focus in mathematics education, as it can help improve their understanding and representation skills, ultimately leading to better overall learning outcomes.

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