Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

Analysis of Junior High School Students' Mathematical Representation Ability Based on Self-Efficacy in Relations and Functions

Yan Ayu Lintang Sagita, Petrus Fendiyanto*
Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Mulawarman, Indonesia.
*Corresponding Author. Email: petrus@fkip.unmul.ac.id

Abstract: This study aims to analyze students' mathematical representation abilities in relation to their levels of self-efficacy in learning the topic of relations and functions. Employing a descriptive qualitative approach, this study involved 23 eighth-grade students from a public junior high school in East Kalimantan, Indonesia. Based on the results of a self-efficacy questionnaire, students were classified into three groups: high, moderate, and low self-efficacy. Six students were then purposively selected for further in-depth analysis using a mathematical representation ability test and semi-structured interviews. Data were analyzed through the processes of data condensation, data display, and conclusion drawing, with source triangulation applied to ensure the credibility of the findings. The results showed that students with high self-efficacy demonstrated a very high level of mathematical representation ability (87.5%) and consistently employed visual, symbolic, and verbal representations. Students with moderate self-efficacy achieved a moderate level of mathematical representation ability (58.33%), indicating sufficient conceptual understanding but inconsistencies in procedural application. Meanwhile, students with low self-efficacy exhibited a low level of mathematical representation ability (20.83%), characterized by limited confidence and difficulties in expressing mathematical ideas effectively. These findings suggest that teachers should design learning experiences that simultaneously enhance students' self-efficacy and encourage the use of various mathematical representations, including visual, symbolic, and verbal forms. Furthermore, curriculum developers should develop instructional activities and assessment frameworks that integrate multiple representation modes while fostering students' confidence in communicating mathematical ideas. Such efforts may contribute to deeper mathematical understanding and improved problem-solving skills.

Article History
Received: 22-01-2026
Revised: 10-04-2026
Accepted: 15-06-2026
Published: 20-07-2026

Key Words:
Functions, Mathematical Representation; Self-efficacy; Relations.

How to Cite: Sagita, Y. A. L., & Fendiyanto, P. (2026). Analysis of Junior High School Students' Mathematical Representation Ability Based on Self-Efficacy in Relations and Functions. *Jurnal Paedagogy*, *13*(3), 999-1010. https://doi.org/10.33394/jp.v13i3.19416

https://doi.org/10.33394/jp.v13i3.19416

Introduction

Education plays a strategic role in developing human resources equipped with critical, logical, and systematic thinking skills. Within mathematics education, the strengthening of numeracy literacy has become a central orientation of the Merdeka Curriculum in response to the demand of 21st-century learning, which emphasizes students' capacity to understand, interpret, and solve problems meaningfully across diverse real-life contexts (Nuryami, 2024). Numeracy literacy is therefore no longer conceptualized merely as procedural competence but encompasses the ability to construct, represent, and communicate mathematical ideas coherently and reflectively (Kusuma et al., 2022). In this context, mathematical representation ability constitutes a fundamental cognitive underpinning of numeracy literacy. Mathematical representation enables students to express, connect, and transform

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id
Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

mathematical ideas into multiple forms, including symbols, tables, diagrams, graphs, and other visual representations, thereby rendering abstract concepts more accessible and contextually meaningful (Ahmad et al., 2023; Sterner et al., 2020). Beyond serving as visual support, representations function as a cognitive tool that facilitates students' construction, exploration, and validation of conceptual understanding at a deeper level (Azmidar et al., 2021).

Moreover, mathematical representation ability plays a pivotal role in the communication of mathematical ideas. Students who possess strong representational skills are generally able to articulate their reasoning processes systematically, present solutions logically, and interpret as well as evaluate representations produced by others (Priatna et al., 2022). Consequently, mathematical representation contributes directly to the development of mathematical reasoning and communication, both of which are integral components of numeracy literacy. The importance of mathematical representation has become increasingly pronounced in the context of 21st-century learning, particularly in conjunction with the integration of digital technology and the adoption of problem-based learning approaches. Learning environments that promote the use of diverse media, technological tools, and authentic contexts encourage students to develop representational flexibility. Through such environments, students are not limited to symbolic procedures but are supported in meaningfully linking mathematical concepts to real-world situations (Pedersen et al., 2021). Accordingly, fostering mathematical representation ability should be a central consideration in the design of mathematics instruction aimed at strengthening numeracy literacy.

Despite its acknowledged importance, empirical evidence suggests that students' mathematical representation ability, especially at the junior high school level, remains underdeveloped (Maryanti et al., 2025). Students frequently encounter difficulties in translating verbal information into appropriate visual or symbolic representations and in accurately interpreting relationships among different forms of representation (Nurrahmawati et al., 2021). Within the topic of relations and functions, such limitations often result in fundamental conceptual errors, including difficulties in distinguishing between relations and functions and inaccuracies in identifying domains and codomains (Agustin & Ruli, 2023; Merliza, 2020). These findings underscore that mathematical representation continues to be a critical challenge in junior high school mathematics learning. Importantly, challenges related to mathematical representation cannot be adequately explained from a purely cognitive perspective. Recent studies have demonstrated that affective factors, particularly self-efficacy, play a significant role in students' success in learning mathematics. Self-efficacy influences students' confidence in selecting problem-solving strategies, employing various forms of mathematical representation, and sustaining effort when faced with difficulties. Students with high self-efficacy tend to demonstrate greater confidence, adaptability, and persistence in exploring mathematical representations, whereas those with low self-efficacy are more likely to experience doubt and disengage from problem-solving activities (Nurani et al., 2021). Nevertheless, although self-efficacy has been widely examined in relation to mathematics achievement, motivation, and problem-solving performance, its relationship with students' mathematical representation ability in specific mathematical domains remains insufficiently explored. This issue is particularly relevant in the topic of relations and functions, where understanding depends heavily on students' ability to construct, interpret, and translate among visual, symbolic, and verbal representations. Examining mathematical representation ability through the lens of self-efficacy can therefore reveal how students' beliefs about their capabilities influence representational thinking and conceptual

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

development, providing a perspective that is not adequately captured in broader self-efficacy research.

Based on these considerations, the scientific contribution of this study lies in its contextual examination of students' mathematical representation ability in relation to varying levels of self-efficacy within the topic of relations and functions. Unlike prior studies that tend to examine cognitive and affective dimensions in isolation, this study seeks to elucidate the characteristics of mathematical representations exhibited by students across different self-efficacy categories. In doing so, the study aims to provide a more comprehensive understanding of the interplay between cognitive and affective factors in mathematics learning.

The findings of this study are expected not only to enrich the theoretical discourse on mathematical representation and self-efficacy but also to yield pedagogical insights for the development of more adaptive and responsive instructional strategies that align with students' characteristics. Accordingly, this study aims to analyze and describe junior high school students' mathematical representation ability in relation to their levels of self-efficacy in the topic of relations and functions.

Research Method

This study employs a descriptive method with a qualitative approach aimed at providing an in-depth description of students' mathematical representation abilities in relation to their levels of self-efficacy. The qualitative approach is chosen as it enables a comprehensive understanding of the characteristics, variations, and patterns of students' mathematical representations in a natural context, without the implementation of instructional interventions or hypothesis testing (Lapan et al., 2011; Sidiq & Choiri, 2019).

Data were collected using three main instruments: (1) a self-efficacy questionnaire to identify students' confidence levels in learning mathematics, (2) a mathematical representation ability test consisting of three open-ended questions developed based on indicators of mathematical representation ability, and (3) a semi-structured interview guide used to explore students' thinking processes and representation strategies across different self-efficacy categories (Arikunto, 2021). The self-efficacy questionnaire and the mathematical representation test were first reviewed by experts in mathematics education and educational assessment to establish content validity. Following expert validation, the instruments were revised and pilot-tested to ensure clarity and suitability for junior high school students. In this qualitative study, the researcher served as the primary instrument and was directly involved in the processes of data collection, analysis, and interpretation.

Data analysis was conducted qualitatively through three stages: data reduction, data display, and conclusion drawing (Miles et al., 2013). Data reduction was carried out by classifying and selecting data obtained from the self-efficacy questionnaire, the mathematical representation ability test, and the interviews in accordance with the research focus. The reduced data were then presented in the form of tables and descriptive narratives to identify patterns and characteristics of students' mathematical representation abilities within each self-efficacy category. The final stage involved drawing conclusions based on the relationships among the research findings. Data validity was ensured through methodological triangulation by comparing and cross-checking findings derived from the mathematical representation ability test and the semi-structured interviews. The consistency of evidence obtained from these different data collection methods was used to verify the accuracy of interpretations and enhance the credibility and trustworthiness of the research findings.

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

Results and Discussion

This study involved 23 eighth-grade students from class VIII B of SMP Negeri 37 Samarinda who had previously studied the topic of relations and functions. Based on the results of the self-efficacy questionnaire, the students were classified into three categories: high self-efficacy (5 students), moderate self-efficacy (15 students), and low self-efficacy (3 students). From each category, two students were selected as research subjects for in-depth analysis through mathematical representation ability tests and interviews. The analysis focused on three aspects of mathematical representation: visual, symbolic, and verbal, to obtain a comprehensive description of students' mathematical representation abilities in terms of their self-efficacy levels.

1) Analysis of Students' Mathematical Representation Ability with High Self-Efficacy

In the visual representation task, subject A09 was asked to represent the relation from a set of ordered pairs in the form of a Cartesian coordinate system and an arrow diagram. Based on the student's work, the subject was able to draw the horizontal and vertical axes accurately, place the elements of sets P and Q on the respective axes, and correctly plot the relational points such as (1,1), (1,4), and (2,2). In the arrow diagram representation, the subject also presented the two sets separately and connected their elements according to the given relational pairs (Figure 1).

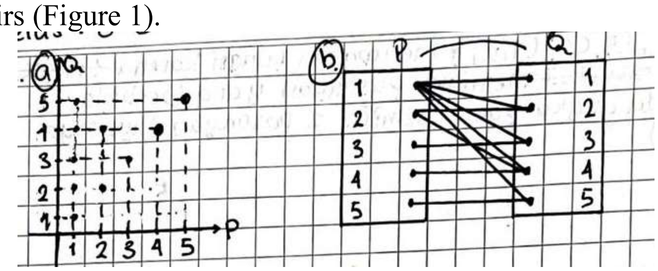

Figure 1. Subject A09's Written Response to the Visual Representation Task

These results indicate that the subject understood the concept of relations and was able to accurately translate it into two forms of visual representation. Further clarification was obtained through the following interview.

R : How did you draw the relation on the Cartesian coordinate system?
A09 : First, I drew the coordinate axes, then placed the elements on the P and Q axes, and identified the corresponding intersection points. For example, when 1 in set P is paired with 1 in set Q, the resulting point is (1,1).
R : Then, how did you represent it using an arrow diagram?
A09 : I first constructed sets P and Q, and then drew arrows according to the given relational pairs.

This statement indicates that the subject understood that coordinates and arrow diagrams are transformations of ordered pairs. Therefore, it can be concluded that subject A09 was able to construct Cartesian coordinates and arrow diagrams in a complete, accurate, and systematic manner.

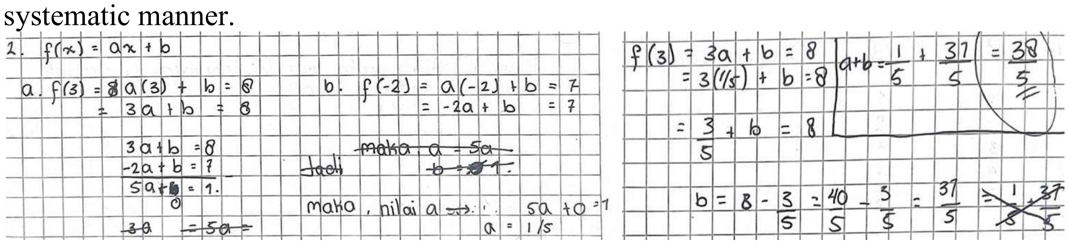

Figure 2. Subject A12's Written Response to the Symbolic Representation Task

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

In the symbolic representation tas, subject A12 was asked to determine the values of a and b in the linear function $f(x) = ax + b$ based on the information $f(3) = 8$ and $f(-2) = 7$. From the answer sheet, it can be observed that the subject was able to formulate two equations are $3a + b = 8$ and $-2a + b = 7$, then apply the elimination method to obtain $a = \frac{1}{5}$ and $b = \frac{37}{5}$. The result was expressed as $a + b = \frac{38}{5}$, which is mathematically correct (Figure 2). Further clarification was obtained through the following interview.

R : Could you describe the steps you used to solve the second question?

A12 : I contructed two equations from the function, namely $3a + b = 8$ and $-2a + b = 7$. Then, I subtracted the equations to eliminate b, which resulted in $a = \frac{1}{5}$. Afterward, I substituted in $3a + b = 8$, to determine $= \frac{37}{5}$.

R : Therefore?

A12 : $a + b = \frac{38}{5}$

The subject demonstrated a clear understanding of the process of constructing a mathematical model from verbal information, applied appropriate solution procedures, and performed the calculations accurately. Therefore, it can be concluded that subject A12 was able to formulate the mathematical model correctly and obtain an accurate solution. However, the problem-solving steps employed were not yet fully systematic.

In the verbal representation task, the subject was asked to determine whether a given relation constituted a function. Subject A09 identified relation (i) as a function and stated that relation (ii) was not a function. Although the written explanation was brief, the response indicates that the subject understood the concept of a function as a relation in which each element in the domain has exactly one corresponding element in the codomain (Figure 3).

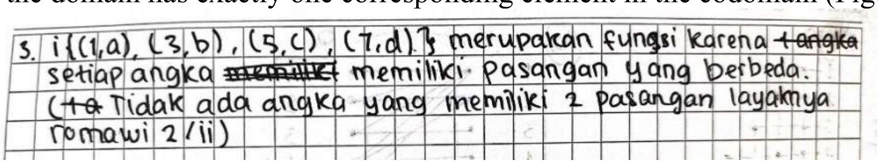
3. i {(1,a), (3,b), (5,c), (7,d)} merupakan fungsi karena ~~angka~~ setiap angka ~~memiliki~~ memiliki pasangan yang berbeda. (~~ta~~ Tidak ada angka yang memiliki 2 pasangan layaknya romawi 2 / ii)

Figure 3. Subject A09's Written Response to the Verbal Representation Task

Further clarification was obtained through the following interview.

R : How did you solve question number three?

A09 : The problem required the identification of which relation constitutes a function. The correct answer is relation (i).

R : What was your reason for selecting relation (i) as a function?

A09 : Relation (i) was selected because each element in the domain has exactly one distinct corresponding element in the codomain. In contrast, in relation (ii), there is an element, namely 1, that has two corresponding elements, a and b. Therefore, relation (i) constitutes a function, whereas relation (ii) does not.

This statement indicates that the subject was able to identify the conditions of a function verbally and articulate the reasoning accurately. This suggests that subject A09 understood the concept of a function correctly and was able to explain it clearly and systematically.

2) **Analysis of Students' Mathematical Representation Ability with Medium Self-Efficacy**

In the visual representation task, subject A23 was required to represent a relation using Cartesian coordinates and an arrow diagram. Based on the student's work, both forms of representation were presented in a reasonably clear and organized manner. The points on the Cartesian plane were plotted in accordance with the given ordered pairs, and the arrows in

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

the arrow diagram accurately indicated the relationships from the domain to the codomain (Figure 4).

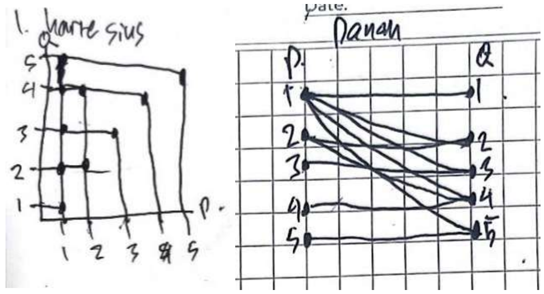

Figure 4. Subject A23's Written Response to the Visual Representation Task

Further clarification was obtained through the following interview.

R : What procedure did you employ to determine and plot the points on the Cartesian coordinate system?

A23 : I determined the points by referring to the given ordered pairs. For example, for the pair (1,5), the value 1 was plotted on the horizontal axis and the value 5 on the vertical axis, after which the point was placed at the corresponding position. The same procedure was applied to the other ordered pairs.

R : Subsequently, what procedure did you use to construct and represent the relation in the arrow diagram?

A23 : Two boxes were constructed to represent the respective sets, and the corresponding elements were placed within each set. Subsequently, arrows were drawn from set P to set Q in accordance with the ordered pairs provided in the problem.

Based on the interview results, it is evident that the subject did not merely imitate the visual form but demonstrated an understanding of the purpose of visual representations, namely to depict the relationships among elements within a relation. Therefore, it can be concluded that subject A23 is able to construct diagrams or visual representations in a complete, accurate, and systematic manner.

In the symbolic representation task, subject A16 was asked to determine the values of a and b in the linear function $f(x) = ax + b$ based on the information $f(3) = 8$ and $f(-2) = 7$. The analysis indicates, that the subject was able to correctly formulate the initial equations, namely $a(3) + b = 8$ and $f(-2) = 7$. However, the subject did not proceed to the subsequent step of solving for a and b using either the elimination or substitution method (Figure 5).

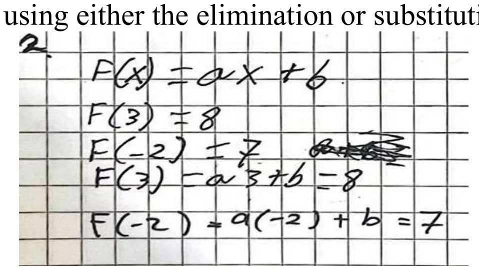

Figure 5. Subject A16's Written Response to the Symbolic Representation Task

Further clarification was obtained through the following interview.

R : What procedure or steps did you follow to solve question number two?

A16 : I began by expressing the linear function as $f(x) = ax + b$. Using the information $f(3) = 8$**,** I formulated the equation $a(3) + b = 8$, and the same procedure was applied to the other given information to construct the second equation.

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

R : Subsequently, what steps did you take to solve the equations and determine the values of a and b ?
A16 : I encountered difficulties in determining the steps required to solve the equations.
R : What procedure is used to determine the value of the form of the two equations?
A16 : I have previously worked on a similar problem; however, I am currently unable to recall the solution procedure.

Based on the interview, subject A16 demonstrated an understanding of the basic form of a function and was able to construct a mathematical model from the provided information; however, they had not yet mastered the procedures required to determine the variable values. Thus, subject A16 is capable of accurately formulating the mathematical model but is unable to compute the final solution.

In the verbal representation task, subject A16 identified relation (i) as a function and justified the choice by stating that each element of the domain is paired with exactly one element in the codomain. Although the language used was not entirely precise, the subject provided a simple arrow diagram clearly illustrating this mapping, consistent with the formal definition of a function (Figure 6).

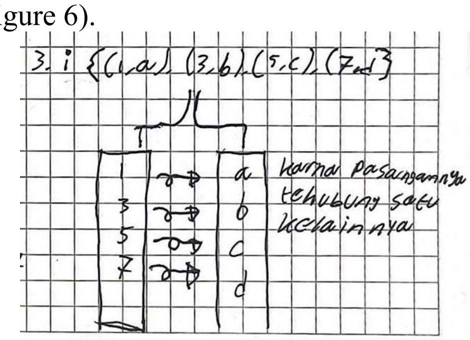

Figure 6. Subject A16's Written Response to the Verbal Representation Task

Further clarification was obtained through the following interview.

R : What procedure or steps did you follow to solve question number three?
A16 : Relation (i) qualifies as a function because each element in the domain is mapped to exactly one element in the codomain. No domain element is paired with more than one codomain element, thus satisfying the definition of a function.
R : Why is relation (ii) not considered a function?
A16 : Element 1 in the domain is mapped to two different elements in the codomain, namely a and b, which violates the criteria of a function.

Based on the interview, subject A16 demonstrated an understanding of the fundamental principle of a function, namely that each element in the domain must have exactly one corresponding element in the codomain. The subject was able to identify the violation of this principle in relation (ii), although they were not fully able to express it in formal written language. Therefore, it can be concluded that subject A16 is capable of providing mathematically accurate explanations consistent with the concept, despite minor linguistic inaccuracies.

3) Analysis of Students' Mathematical Representation Ability with Low Self-Efficacy

In the visual representation task, subject A05 completed both the Cartesian coordinate and arrow diagram representations; however, conceptual errors were observed. The domain was placed on the vertical axis and the codomain on the horizontal axis, resulting in an inversion of the relational points. Similarly, in the arrow diagram, the arrows were drawn from the codomain to the domain (Figure 7).

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

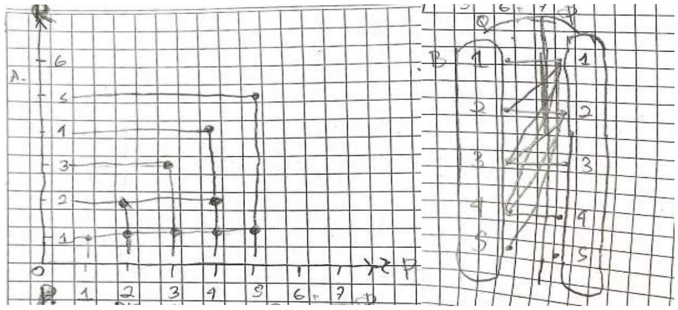

Figure 7. Subject A05's Written Response to the Visual Representation Task

Further clarification was obtained through the following interview.

R : How did you solve this question?

A05 : In the Cartesian coordinate representation, I plotted points P and Q and then matched them with their corresponding pairs. For example, I drew a line from 1 on the vertical axis to 1 at point P. In the arrow diagram, I first listed the elements of the sets and then drew arrows according to the corresponding pairs.

R : How did you represent the pair (2,4) in the visual representation?

A05 : At first, I drew a line from 2 on the right to 4 on the left, but it seems the placement was reversed.

R : Are you sure?

A05 : The positions appear to be reversed. The line should have been drawn from 2 on the left side to 4 on the right side. I forgot the correct order when completing the task.

Based on the interview results, the participant exhibited uncertainty in understanding the structure of relations in both the Cartesian coordinate system and the arrow diagram. Although they attempted to arrange the pairs according to the task, errors in the placement of the domain and codomain indicate conceptual misunderstandings. Thus, it can be concluded that participant A05 was able to create the drawings or diagrams, but there were still inaccuracies in their representation.

In the symbolic representation task, subject 005 was asked to determine the values of a and b for the linear function $f(x) = ax + b$ based on the information $f(3) = 8$ and $f(-2) = 7$. Based on their work, the subject merely copied the function values from the problem without constructing a correct mathematical model. The subject wrote $a + b = 2 + 7 = 9 - 8 = 1$, which does not conform to the proper procedure for solving a linear function. This indicates that the participant has not yet understood the use of symbolic function forms in the context of equations (Figure 8). Further clarification was obtained through the following interview.

R : On your answer sheet, you wrote $f(3) = 8$. Could you explain what you meant by this statement?

A05 : I did not know. The value was provided in the problem, so I simply copied it.

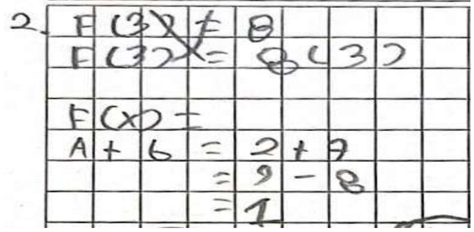

Figure 8. Subject A05's Written Response to the Symbolic Representation Task

Based on the interview, subject A05 did not understand the meaning of the symbol $f(x)$ and was unsure how to construct an equation from the given information. The subject

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

did not perform substitution or elimination, indicating a lack of mastery of the algebraic procedures. Therefore, subject A05 was able to identify a mathematical model, but the solution was incorrect.

In the verbal representation task, subject A21 was asked to identify which relations were functions based on two sets of ordered pairs. The participant only provided illustrations using a Cartesian coordinate system and an arrow diagram, without any written explanation. No reasoning was given for the pairings, and it was not stated whether the relations were functions (Figure 9).

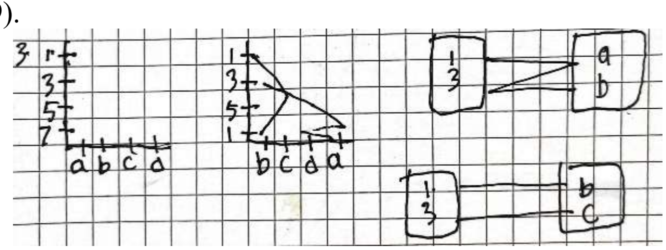

Figure 9. Subject A16's Written Response to the Verbal Representation Task

Further clarification was obtained through the following interview.

R : In question 3, you were asked to provide an explanation. Why did you not write down the reason?

A16 : I don't know the answer.

R : Do you know what constitutes a relation that is not a function, or the difference between such a relation and a function?

A16 : I don't know.

Based on the interview, subject A21 did not clearly understand the difference between a function and a relation that is not a function. The participant appeared uncertain about their answer and only provided illustrations without any written explanation. This indicates that their verbal representation skills were not demonstrated.

Based on the analysis, students' mathematical representation abilities were categorized according to their levels of self-efficacy, namely high, medium, and low. The analysis considered three aspects of mathematical representation: visual, symbolic, and verbal. Table 1 presents a summary of the percentages of students demonstrating competence in each aspect across the different self-efficacy levels. This table allows for a comparative overview of how self-efficacy correlates with students' abilities to represent mathematical concepts.

Table 1. Students' Mathematical Representation Abilities Based on Self-Efficacy Levels

As Mathematical Representation Aspect	High Self-efficacy	Medium Self-efficacy	Low Self-efficacy
Visual Representation	100%	87,5%	25%
Symbolic Representation	75%	37,5%	25%
Verbal Representation	87.5%	50%	12.5%
Average (%)	87.5%	58.33%	20.83%
Category	Very High	Medium	Low

Students with high self-efficacy demonstrated consistency across the three aspects of mathematical representation. In the visual aspect, they were able to accurately transform information into graphs and diagrams. In the symbolic aspect, they were capable of constructing mathematical models and selecting appropriate solution strategies, although minor procedural inaccuracies were observed. In the verbal aspect, they were able to provide written justifications clearly and confidently, albeit briefly. The overall achievement of

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

students with high self-efficacy was classified as very high, with an average score of 87.5% (Table 1). These findings are consistent with Holenstein et al. (2022) and Rahmawati et al. (2022), who stated that self-efficacy plays a significant role in promoting perseverance, accuracy, and the ability to express mathematical ideas. Thus, a strong sense of self-efficacy appears to support the effective use of various forms of representation in problem-solving.

Students with medium self-efficacy demonstrate varied levels of mathematical representation ability across different aspects. In visual representation, they are able to transform information into diagrams or graphs with reasonable accuracy, indicating the presence of initial conceptual understanding. However, their performance in symbolic and verbal representations tends to be inconsistent. Although students can recognize general solution patterns and understand the direction of problem-solving, they often hesitate to complete procedures fully and present them coherently. This reflects a typical characteristic of learners with moderate self-efficacy, who possess adequate conceptual understanding but lack strong confidence in their chosen strategies. Overall, the mathematical representation ability of students in this group falls within the moderate category, with an average achievement rate of 58.33% (Table 1). These findings are consistent with previous studies Pravesti et al. (2024) and Nurani et al. (2021), which report that students with moderate self-efficacy exhibit conceptual potential but tend to be less persistent in problem-solving, resulting in uneven performance. Therefore, strengthening students' confidence and fostering systematic thinking processes are essential to improve the consistency of their performance.

Students with low self-efficacy exhibit limitations across all aspects of mathematical representation. In visual representation, some students are able to present relations in the form of graphs or diagrams; however, they still make fundamental errors in identifying domains and codomains. Uncertainty in responding and a tendency to doubt their own answers indicate weak self-confidence in applying mathematical concepts. In symbolic representation, students tend to merely copy the general form of a function without proceeding to subsequent steps, reflecting low persistence in completing solution procedures. Verbal representation emerges as the weakest aspect, as students are unable to articulate written or oral explanations to justify their representational outcomes. Low self-confidence combined with conceptual confusion prevents mathematical ideas from being communicated coherently. Overall, the mathematical representation ability of students with low self-efficacy falls within the low category, with an average achievement rate of 20.83%. (Table 1) This finding supports previous studies Nisa & Arliani (2023) and Suciati et al. (2024), which report that low self-efficacy is associated with limited persistence and low confidence in applying problem-solving strategies. Although this result differs from the findings of Said et al. (2021), who reported that students with low self-efficacy could still achieve a moderate level, the discrepancy may be attributed to differences in the classification criteria of self-efficacy used across studies.

Conclusion

This study concludes that students' mathematical representation abilities are closely associated with their levels of self-efficacy. Students with high self-efficacy tend to demonstrate more comprehensive and balanced use of visual, symbolic, and verbal representations, enabling them to express and connect mathematical ideas effectively. In contrast, students with moderate self-efficacy generally possess adequate conceptual understanding but may struggle to apply appropriate representation strategies consistently. Meanwhile, low self-efficacy appears to constrain students' ability to construct and

Vol. 13 No. 3 : July 2026
E-ISSN: 2722-4627
pp. 999-1010

communicate mathematical representations, as uncertainty about their own capabilities often hinders engagement with mathematical tasks. These findings suggest that self-efficacy functions not only as an affective factor but also as an important support for students' representational thinking and mathematical communication. Therefore, mathematics instruction should incorporate learning experiences that simultaneously foster students' confidence and develop their ability to use multiple mathematical representations.

Recommendation

The findings of this study suggest that mathematics teachers should provide supportive learning environments that strengthen students' self-efficacy while engaging them in visual, symbolic, and verbal mathematical representations. Future research is recommended to investigate instructional interventions that simultaneously enhance self-efficacy and mathematical representation ability across different mathematical topics and educational levels. Limitations related to students' prior knowledge, learning experiences, and self-efficacy classification should also be considered to improve the robustness and generalizability of future findings.

References

Agustin, R., & Ruli, R. M. (2023). Analisis Kesulitan Siswa SMP Dalam Menyelesaikan Soal Materi Fungsi Dan Relasi. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *6*(1), 227–234. https://doi.org/10.22460/jpmi.v6i1.14578

Ahmad, A., Akhsani, L., & Mohamed, Z. (2023). The profile of students' mathematical representation competence, self-confidence, and habits of mind through problem-based learning models. *Infinity Journal*, *12*(2), 323–338. https://doi.org/10.22460/infinity.v12i2.p323-338

Arikunto, S. (2021). *Dasar-Dasar Evaluasi Pendidikan Edisi 3*. Bumi Aksara.

Azmidar, A., Darhim, D., & Dahlan, J. A. (2021). Enhancing Students' Mathematical Representation Ability Using the Concrete-Pictorial-Abstract Approach. *Jurnal Pendidikan MIPA*, *22*(1), 67–76. https://doi.org/10.23960/jpmipa/v22i1.pp67-76

Holenstein, M., Bruckmaier, G., & Grob, A. (2022). How do self-efficacy and self-concept impact mathematical achievement? The case of mathematical modelling. *The British Journal of Educational Psychology*, *92*(1), e12443. https://doi.org/10.1111/bjep.12443

Kusuma, D., Sukestiyarno, Y. L., Wardono, & Cahyono, A. N. (2022). The Characteristics of Mathematical Literacy Based on Students' Executive Function. *European Journal of Educational Research*, *11*(1), 193–206. https://doi.org/10.12973/eu-jer.11.1.193

Lapan, S. D., Quartaroli, M. T., & Riemer, F. J. (2011). *Qualitative Research: An Introduction to Methods and Designs*. John Wiley & Sons.

Maryanti, A., Putra, H. D., & Yuspriyati, D. N. (2025). Peningkatan Kemampuan Representasi Matematis Siswa Menggunakan Model Problem Based Learning. *Jurnal Pembelajaran Matematika Inovatif*, *8*(2), 227–236. https://doi.org/10.22460/jpmi.v8i2.26887

Merliza, P. (2020). Kemampuan Representasi Matematis Peserta Didik Pada Materi Relasi Dan Fungsi Di Kelas VIII B SMP Darul Ulum Sekampung. *Math Educa Journal*, *4*(2), 144–156. https://doi.org/10.15548/mej.v4i2.1815

Miles, M. B., Huberman, A. M., & Saldana, J. (2013). *Qualitative Data Analysis: A Methods Sourcebook*. SAGE Publications.

Nisa, F. K., & Arliani, E. (2023). Junior high school students' mathematical literacy in terms of mathematical self-efficacy. *Jurnal Elemen*, *9*(1), 283–297. https://doi.org/10.29408/jel.v9i1.7140

Nurani, M., Riyadi, R., & Subanti, S. (2021). Profil Pemahaman Konsep Matematika Ditinjau Dari Self Efficacy. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(1), 284. https://doi.org/10.24127/ajpm.v10i1.3388

Nurrahmawati, Sa'dijah, C., Sudirman, S., & Muksar, M. (2021). Assessing students' errors in mathematical translation: From symbolic to verbal and graphic representations. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(1), 115–125. https://doi.org/10.11591/ijere.v10i1.20819

Nuryami, N. (2024). Numeracy literacy of junior high school students in implementing the Merdeka mathematics learning curriculum. *Alifmatika: Jurnal Pendidikan Dan Pembelajaran Matematika*, *6*(1), 63–77. https://doi.org/10.35316/alifmatika.2024.v6i1.63-77

Pedersen, M. K., Bach, C. C., Gregersen, R. M., Højsted, I. H., & Jankvist, U. T. (2021). Mathematical Representation Competency in Relation to Use of Digital Technology and Task Design—A Literature Review. *Mathematics*, *9*(4), 444. https://doi.org/10.3390/math9040444

Pravesti, C. A., Mufidah, E. F., Nurlitasani, E. N., Lathifah, M., & Wulansari, P. S. D. (2024). Analysis of students self-efficacy level. *JPPI (Jurnal Penelitian Pendidikan Indonesia)*, *10*(4), 641–646. https://doi.org/10.29210/020242214

Priatna, N., EfridaMuchlis, E., & Maizora, S. (2022). Analysis of students' mathematical communication skills in web-based geometry in space and plane learning. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 224–236. https://doi.org/10.23917/jramathedu.v7i4.17498

Rahmawati, R. D., Dwiningrum, S. I. A., & Fredy. (2022). Determinants of Self Efficacy in Mathematical Communication Elementary School Students. *AL-ISHLAH: Jurnal Pendidikan*, *14*(3), 3693–3704. https://doi.org/10.35445/alishlah.v14i3.1827

Said, R. S., Subarinah, S., Baidowi, & Sripatmi. (2021). Kemampuan Representasi Matematis Ditinjau Dari Self Efficacy Siswa Kelas VIII Tahun Ajaran 2020/2021. *Griya Journal of Mathematics Education and Application*, *1*(3), 306–315. https://doi.org/10.29303/griya.v1i3.84

Sidiq, U., & Choiri, M. M. (2019). *Metode Penelitian Kualitatif di Bidang Pendidikan*. Nata Karya. https://repository.iainponorogo.ac.id/484/

Sterner, G., Wolff, U., & Helenius, O. (2020). Reasoning about Representations: Effects of an Early Math Intervention. *Scandinavian Journal of Educational Research*, *64*(5), 782–800. https://doi.org/10.1080/00313831.2019.1600579

Suciati, S., Sulistyowati, R., & Suhartini, R. (2024). The Influence of Problem-Solving Skills and Self-Efficacy on Learning Outcomes in Skills Concentration Subjects. *Briliant: Jurnal Riset Dan Konseptual*, *9*(4), 861–870. https://doi.org/10.28926/briliant.v9i4.1931