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ANALYSIS OF IMPERFECTION OF MATHEMATICAL IDENTITY IN PROBLEM-SOLVING

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Abstrak

Ketidaksesuaian antara identitas matematis yang kuat dan kinerja akademik siswa menunjukkan bahwa faktor kontekstual dan kognitif berperan dalam memengaruhi kemampuan pemecahan masalah matematika. Penelitian ini bertujuan untuk menganalisis dampak ketidaksempurnaan identitas matematis terhadap kemampuan siswa dalam menyelesaikan masalah matematika. Menggunakan pendekatan kualitatif dengan metode studi kasus. penelitian ini melibatkan siswa kelas VIII SMP Muhammadiyah 7 Jember yang memiliki identitas matematis tinggi namun prestasi akademik rendah. Data dikumpulkan melalui angket, tes kinerja, dan wawancara. Hasil penelitian mengungkapkan adanya ketidaksesuaian antara identitas matematis yang tinggi (73%) dan prestasi akademik yang rendah, terutama dalam dimensi kompetensi (56%) dan kinerja (59%). selain itu, penelitian ini menunjukkan bahwa rendahnya rasa percaya diri, ketidakpastian dalam memilih strategi, dan keterbatasan dalam penerapan pendekatan yang efektif menghambat pencapaian akademik siswa. oleh karena itu, penelitian ini menekankan pentingnya peran guru dalam mengembangkan keterampilan praktis dan menerapkan pendekatan berbasis konsep serta sistematis untuk meningkatkan kemampuan pemecahan masalah siswa. sehingga diperlukan pendekatan pembelajaran yang fleksibel, teknik refleksi untuk memperbaiki kesalahan, dan pembelajaran berbasis masalah yang relevan dengan kehidupan sehari-hari. dengan demikian penelitian lanjutan diperlukan untuk merancang intervensi yang lebih efektif dalam mendukung pengembangan identitas matematis siswa.

Kata kunci: Ketidaksempurnaan Identitas Matematika; Kompetensi Matematika; Pemecahan Masalah Matematika; Refleksi Pembelajaran; Studi Kasus

Abstract

The discrepancy between students' strong mathematical identity and their academic performance indicates that contextual and cognitive factors play a role in influencing their problem-solving abilities in mathematics. This study aims to analyze the impact of imperfect mathematical identity on students' ability to solve mathematical problems. Using a qualitative approach with a case study method, this research involves eighth-grade students from SMP Muhammadiyah 7 Jember who have a strong mathematical identity but low academic achievement. Data were collected through surveys, performance tests, and interviews. The findings reveal a mismatch between the high mathematical identity (73%) and low academic performance, particularly in the dimensions of competence (56%) and performance (59%). Additionally, the study shows that low self-confidence, uncertainty in choosing strategies, and limitations in applying effective approaches hinder students' academic

achievement. Therefore, this research emphasizes the importance of teachers' roles in developing students' practical skills and implementing concept-based, systematic approaches to enhance problem-solving abilities. It calls for a flexible learning approach, reflective techniques to correct errors, and problem-based learning relevant to real-life situations. Further research is needed to design more effective interventions to support the development of students' mathematical identity.

Keywords: Mathematical Identity Imperfection; Mathematical Problem Solving; Learning Reflection; Mathematical Competence; Case Study

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INTRODUCTION

Mathematical identity is a key factor in mathematics education because it reflects how students view themselves in the context of mathematics. This concept includes students' beliefs, attitudes, and engagement in mathematical activities, all of which influence their motivation, perseverance, and problem-solving abilities activities (Ryan et al., 2022; Sturm & Bohndick, 2021). A positive mathematical identity can encourage students to be more confident, persistent, and capable of choosing effective strategies when facing mathematical challenges (Barba, 2022; Latuwael, 2022). On the other hand, imperfections in mathematical identity, such as anxiety or fear of failure, can hinder student engagement and negatively impact their performance (Hiller et al., 2022; Supriadi et al., 2024). Therefore, it is essential to explore the factors affecting mathematical identity and its impact on problem-solving skills to support students' optimal development in mathematics education.

The impact of a strong mathematical identity is not only evident in academic contexts but also plays a significant role in students' personal development. Mathematics, as a fundamental discipline, not only enhances critical thinking and problem-solving skills but also opens up career opportunities in STEM fields (Peciuliauskiene, 2023). Students with a positive mathematical identity are better able to face challenges, adapt to various tasks, and remain motivated in learning, which allows them to achieve better academic results and develop sustainable

mathematical competencies (Ekmekci & Serrano, 2022; Gweshe & Brodie, 2023). Conversely, students with a weak mathematical identity often experience anxiety, avoid mathematical tasks, and become less engaged in learning (Anjasari et al., 2023; Rusyda et al., 2021). This not only limits their potential in STEM fields but also exacerbates broader educational and social issues.

While the importance of mathematical identity has been acknowledged, research on this topic still faces various challenges and gaps. Most studies have focused primarily on the positive attributes of mathematical identity, often neglecting the exploration of its imperfections and their impact on learning outcomes (Hima et al., 2019; Maskar & Herman, 2024). While it is known that students with a low mathematical identity often struggle with self-confidence and perseverance, the understanding of the mechanisms behind these struggles and their impact on problem-solving remains limited. Factors such as uncertainty in strategy selection, lack of resilience, and difficulty in applying logical reasoning have not been widely explored within the context of mathematical identity (Jiang et al., 2021). Therefore, understanding these dynamics is crucial for designing more effective interventions to support students facing these challenges in mathematical problem-solving.

Another significant issue lies in the mismatch between mathematical identity and students' academic performance. While students with a strong mathematical identity are expected to perform well, some still struggle with solving mathematical problems (Uwerhiavwe, 2023; Wahyuni et al., 2024). This mismatch suggests that a strong mathematical identity alone is not sufficient to guarantee success, as other contextual and cognitive factors also play a role in influencing their performance. Furthermore, while the role of teachers in creating a supportive learning environment has been shown to be important, the limited practical strategies to address imperfections in mathematical identity present a challenge (DiNapoli, 2023). Therefore, more comprehensive research is needed to understand how

imperfections in mathematical identity affect students' problem-solving abilities and to identify applicable solutions that can improve their learning experience.

This study aims to investigate the imperfections in mathematical identity and their impact on students' problem-solving skills. The primary focus of this research is to identify how factors such as low self-confidence, uncertainty in strategy selection, and limitations in applying effective approaches affect students' ability to solve mathematical problems. Therefore, the research question is "How does the imperfection of mathematical identity affect students' ability to solve mathematical problems?" The findings of this study are expected to provide significant contributions to both theory and practice in mathematics education. Theoretically, this research will enrich the understanding of the relationship between mathematical identity and problem-solving, while practically, the findings can help develop interventions and teaching strategies that more effectively address challenges related to mathematical identity, empowering students to overcome barriers in mathematics and reach their full potential.

METHOD

This study uses a qualitative approach with a case study method to describe the imperfections of students' mathematical identities that affect their ability to solve mathematical problems. The subjects of this study were eighth-grade students from SMP Muhammadiyah 7 Jember, selected using purposive sampling. The sample was chosen based on two main criteria: (1) students who have a high mathematical identity but low mathematical achievement, and (2) students who face difficulties in solving mathematical problems despite having a positive attitude and interest in mathematics. The purpose of selecting this specific sample is to explore the imperfections in mathematical identity that may influence students' problem-solving abilities. Although this specific sample selection limits the ability to generalize the findings, this approach enhances internal validity by allowing the researcher to examine deeper factors that affect the relationship between

mathematical identity and problem-solving. Mathematical identity is measured through four dimensions: interest, recognition, competence, and performance.

Table 1. Criteria Mathematical Identity

Score	Criteria
$80 \leq x$	Very High
$70 \leq x < 80$	High
$60 \leq x < 70$	Enough
$x < 60$	Low

In this study, data collection instruments such as questionnaires and performance tests have been tested for reliability and validity. The questionnaire was designed to measure the dimensions of students' mathematical identity, such as interest, recognition, competence, and performance, based on current theories in the field. The reliability of the questionnaire was tested using a reliability test, which showed high internal consistency. The validity of the questionnaire was tested through content validation by experts in mathematics education, ensuring that the instrument measures relevant aspects of mathematical identity. The performance test, used to measure students' ability to solve mathematical problems, has also been tested for validity and reliability. This test was developed with consideration of the appropriate level of difficulty for eighth-grade students and includes a variety of questions that delve into problem-solving. The reliability and validity of both instruments increase the credibility of the research results, although the findings should still be considered in the context of the selected sample.

Mathematical Problem Instruments:

1. The "Gang Damai" consists of rows of houses arranged in an orderly manner. The houses on the right side are numbered oddly (1, 3, 5, …), while those on the left side are numbered evenly (2, 4, 6, …). The number of the 20th house on the left and the number of the 11th house on the right are?
2. Firda has 4 choices of clothing colors (yellow, pink, black, brown) and 5 choices of hijab colors (orange, gray, red, green, blue). Mention all the combinations of clothing and hijab colors that can be chosen!
3. Mr. Soni trained 6 students in playing the piano, with 3 students with even codes and 3 students with odd codes. The even coded students played the

melody “do do do mi re mi do”, while the odd coded students played “do do do mi do re”. The melody was played alternately between the even and odd coded students. The questions were "Which note is pressed on the 20th sequence?", and "who pressed it, (even or odd coded students)?".

RESULTS AND DISCUSSION

The results of this study are presented in two main categories: mathematical identity and problem-solving ability. Mathematical identity was analyzed based on the results of a questionnaire filled out by 17 8th-grade students of SMP Muhammadiyah 7 Jember. The questionnaire was designed to identify students' mathematical identity through four dimensions: interest, recognition, competence, and performance. Meanwhile, mathematical problem-solving ability was measured from students' answers to certain questions, which aimed to assess the extent to which they could solve mathematical problems. These results were strengthened through in-depth interviews to explore factors that influence mathematical identity and its relationship to students' problem-solving abilities.

Mathematical Identity

The mathematics identity questionnaire consists of 24 statements, covering the dimensions of interest (5 positive and 4 negative statements), recognition (3 positive and 5 negative statements), competence (3 positive and 1 negative statement), and performance (1 positive and 2 negative statements). The results of the students' mathematical identity questionnaire are presented in Figure 1 below.

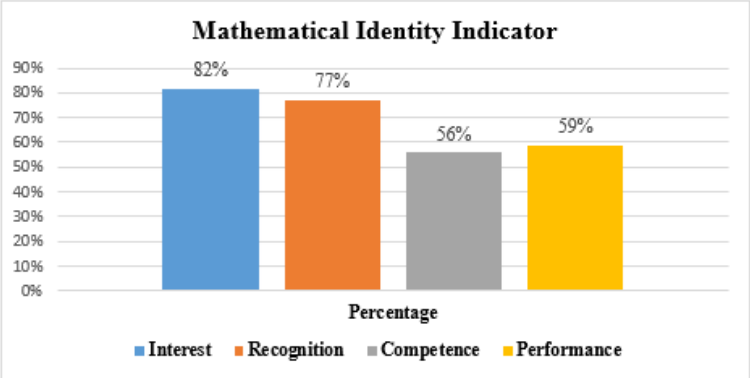

Figure 1. Results of the Students' Mathematical Identity

Figure 1. shows the results of the mathematical identity questionnaire involving 24 statements, namely the overall mathematical identity is in the high category of 73% with details of interest indicators of 82% (obtained from positive statements agree 84% and negative statements 79%), recognition of 77% (obtained from positive statements agree 80% and negative statements 75%), competence of 56% (obtained from positive statements agree 55% and negative statements 22%), and performance of 59% (obtained from positive statements agree 65% and negative statements 56%). This provides an illustration that students' mathematical identity is in the high category, but their achievements are still low, especially in competence (56%) and performance (59%).

The results of this study reveal that although students' mathematical identity is categorized as high, their ability to solve mathematical problems remains low, particularly in the dimensions of competence and performance. Based on the data obtained from the questionnaire, students' interest and recognition in mathematics are very high, reaching 82% and 77%, respectively. However, in the performance and competence tests, the percentages obtained were only 59% and 56%. This indicates a mismatch between strong mathematical identity and academic achievement, which should ideally align if mathematical identity plays an optimal role in supporting problem-solving. Although students have high interest and recognition, they still face difficulties in applying mathematical concepts in more practical situations. This leads to the understanding that interest and recognition alone are not sufficient to improve students' performance in mathematics.

Furthermore, this result strengthens the finding that a strong mathematical identity does not always correlate with academic achievement, especially in terms of competence and performance (Cribbs & Utley, 2023). While students with a strong mathematical identity tend to be more interested in mathematics and are recognized by their surroundings, they still need practical skills and effective problem-solving strategies to succeed. This suggests that teaching factors and the quality of evaluations students receive greatly influence their ability to apply

mathematical theory. Without adequate practical skills, even if students have a good basic understanding, they may still struggle to solve mathematical problems (Hirt et al., 2021; Jiang et al., 2021). Therefore, to enhance mathematical problem-solving ability, it is important not only to strengthen students' mathematical identity but also to develop practical skills and effective teaching approaches that can help students apply mathematical concepts in real-life situations.

Thus, this study emphasizes that a high mathematical identity alone is not enough to guarantee academic success in mathematics. Another important factor is the quality of teaching, which can enhance students' practical skills and create a learning environment that supports the application of mathematical concepts in broader problem-solving contexts. Strengthening both of these aspects will have a positive impact on students' ability to overcome challenges in mathematics and improve their performance. Based on the results of the mathematical identity questionnaire (Figure 1), only 56% of students met the competency criteria, and 59% met the performance criteria. These findings indicate a gap between mathematical identity and academic achievement, particularly in terms of competency and performance. Therefore, further analysis was conducted regarding students' competencies and performance in solving mathematical problems. Competency includes technical skills, logical thinking, and analytical abilities, while performance involves speed, perseverance, and accuracy in solving problems. The subject of this study was coded as "SR".

Answers Problems 1

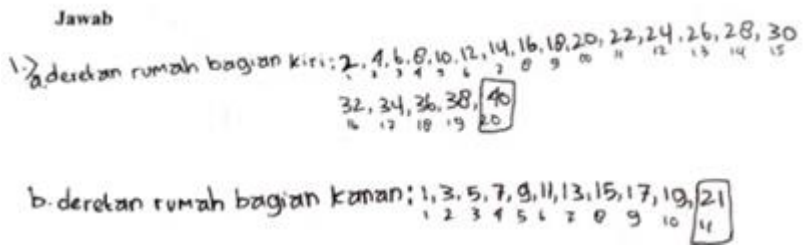

Figure 2. Answer Problems 1

Figure 2 shows SR solving the problem using a listing strategy, whereas they should have applied a systematic formula for even-numbered houses ($2n$) and odd-numbered houses ($2n-1$). Although SR's answer is implicitly correct, the strategy used reflects imperfections in their mathematical identity, particularly regarding technical competence, logical thinking, and analytical skills. Additionally, SR relies more on persistence and speed without a deep understanding of the correct formula. This indicates that SR can arrive at the correct result but has not fully mastered a more systematic and efficient approach to problem-solving in mathematics.

Further findings are evident in an interview with SR, where they state, "*I feel more confident solving by counting one by one*". Moreover, SR also expressed, "*I feel comfortable and confident, even if it takes longer, as long as the result is correct, rather than solving it quickly but inaccurately*". This statement shows that SR is capable of identifying and organizing information but lacks the development of logical and analytical thinking skills. Despite having high persistence, SR tends to choose less efficient strategies, which may sacrifice speed and accuracy. Thus, these findings emphasize the importance of teaching students not only to rely on persistence but also to understand mathematical concepts systematically.

In classroom practice, teachers must guide students in understanding mathematical concepts in a structured manner and encourage the use of efficient strategies so that problems can be solved quickly and accurately without sacrificing persistence. (Fatqurhohman et al., 2024; Kambara, 2022) emphasizes the importance of systematic note-taking, supported by an understanding of efficient formulas, to enhance the effectiveness of mathematical problem-solving. Furthermore, (Fatqurhohman et al., 2023; Latuwael, 2022; Yayuk et al., 2020) indicate that a solid understanding of formulas strengthens students' logical thinking skills and creativity in solving mathematical problems. These findings imply that teachers should not only encourage students' persistence but also guide them in understanding and using more efficient formulas and strategies in problem-solving.

Moreover, flexibility in choosing problem-solving strategies influences the efficiency and accuracy of students' solutions (Canonigo & Joaquin, 2023). Furthermore, (Serin, 2023; Wahyuni et al., 2024) also stress that a deep understanding of systematic formulas is crucial for producing efficient and accurate solutions. Additionally, the findings (Latuwael, 2022; Punia et al., 2022) suggest that a systematic understanding of mathematical concepts not only improves the efficiency of problem-solving but also accelerates the achievement of accurate solutions. Therefore, an educational approach that emphasizes the development of technical, logical, and analytical skills, along with a deep understanding of formulas and strategies, can help students achieve more accurate results without compromising persistence or speed.

Answers Problems 2

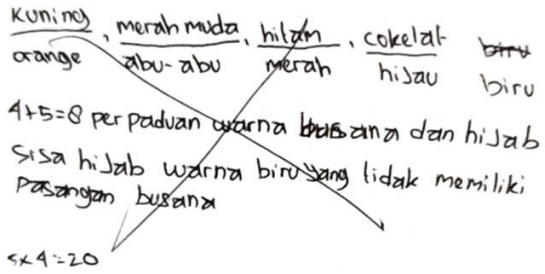

Figure 3. Answer Problems 2

Figure 3 shows that SR faces various imperfections in technical competence, logical thinking, and analytical skills when solving mathematical problems. Basic errors, such as writing "$4 + 5 = 8$" instead of "$4 + 5 = 9$", reflect limitations in understanding fundamental mathematical operations. However, SR eventually recognized the importance of using multiplication to solve the problem, as seen in their effort to determine the combination of clothing and headscarf colors using the concept of "$4 \times 5 = 20$". This reflects SR's attempt to improve their understanding of mathematical concepts through reflection and perseverance.

Furthermore, SR's limitations in understanding the basic concept of combination calculations impacted their logical and analytical thinking abilities.

This was reinforced by SR's statement during the interview: "*I thought the combination of 4 clothes and 5 headscarves used addition. I tried to sort them, but the result was wrong, it should have been multiplication*". This statement indicates confusion in selecting the appropriate mathematical operation. According to (Fatqurhohman et al., 2024; Latuwael, 2022; Raymond et al., 2023), a deep understanding of basic mathematical concepts and formulas is crucial for supporting the development of analytical skills.

Although SR used a slow and inefficient method, they showed a high level of perseverance. In the interview, SR said "*I am not used to combination problems, so I felt confident using addition*". This perseverance allowed SR to reflect on their mistakes and gradually improve their answers. Research (Gweshe & Brodie, 2023; Jiang et al., 2021) revealed that reflection can improve accuracy and precision in problem-solving. Furthermore, studies (Canonigo & Joaquin, 2023; Sturm & Bohndick, 2021) emphasize that an optimistic attitude and flexibility in choosing problem-solving methods can strengthen analytical abilities, ultimately contributing to improved mathematical skills.

These findings highlight the importance of balancing the affective dimension, such as confidence and perseverance, with the cognitive dimension, such as technical competence and a deep understanding of concepts, in developing students' mathematical identities. According to (Canonigo & Joaquin, 2023; Kambara, 2022), an integrative approach is essential for enhancing logical and analytical thinking skills through meaningful learning.

Therefore, concept-based learning is critical because it not only strengthens technical skills but also promotes the development of higher-order thinking. In the classroom, a systematic pedagogical approach, such as authentic problem-based learning relevant to daily life, can reinforce students' mathematical identities. Additionally, teachers can utilize reflection on mistakes to strengthen conceptual understanding and improve students' accuracy. Overall, this study emphasizes that building a comprehensive mathematical identity requires a holistic approach that

integrates strengthening technical competence, logic, and analysis while supporting the development of an optimistic attitude and perseverance, thereby creating an effective learning environment that prepares students to face complex real-life challenges.

Answers Problems 3

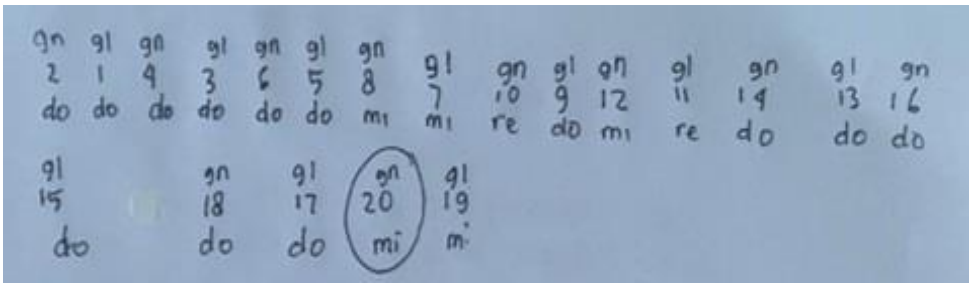

Figure 4. Answer Problems 3

Figure 4 shows that SR, overall, recorded the melody played alternately, starting with the even-numbered students, followed by the odd-numbered students, and so on. This performance indicates imperfections in SR's mathematical identity, particularly related to technical, logical, and analytical competencies. Technically, SR made an error in determining the 20th note sequence for even-numbered students, which should have been the note "*do*", but was recorded as "*mi*". This mistake reflects a lack of precision in applying systematic procedures and a limitation in using more complex and appropriate strategies to solve mathematical problems efficiently.

Another finding revealed in the interview, "*I just coded the students playing even and odd notes alternately, without considering the order of the note pattern*", was reinforced by the statement, "*I thought it was the correct answer and didn't think to check it again*". This suggests that SR relied on a simple linear strategy without considering more complex note patterns, indicating a lack of thoroughness in mapping the pattern. This limitation hindered the achievement of more accurate and efficient solutions. Additionally, SR's failure to review and critically evaluate the results reflects a shortcoming in their problem-solving approach. Logically and analytically, SR did not consider the relationships between recurring patterns and

did not verify their answer, even though verification is crucial to ensure the accuracy of the solution. These findings align with research (Canonigo & Joaquin, 2023; Supriadi et al., 2024), which emphasizes the importance of mastering technical, logical, and analytical competencies in building a strong mathematical identity.

Furthermore, research (DiNapoli, 2023; Peciuliauskiene, 2023) reveals that perseverance and self-confidence can improve students' problem-solving abilities in mathematics. However, reliance on a single strategy without considering more efficient alternatives can hinder the accuracy and speed of problem-solving (Fatqurhohman, 2016). (Gweshe & Brodie, 2023) emphasize the importance of reflection in problem-solving, highlighting the need for students to be aware of the need to check their answers to achieve better results.

In classroom practice, the implications of these findings highlight the importance of teaching students not only to rely on perseverance and self-confidence but also to develop reflection and evaluation skills in the mathematics learning process. Therefore, teachers need to encourage students to review and verify their work and provide opportunities for them to reflect on the strategies used. According to (Barba, 2022; Serin, 2023), developing a strong mathematical identity requires a balance between perseverance, strategy flexibility, and reflection. Thus, to build a deeper understanding, students need to be given space to express and develop components of their mathematical identity, which, in turn, will enhance the effectiveness and efficiency of their mathematical problem-solving.

CONCLUSION

This study reveals that students' mathematical identity is significantly influenced by a balance of perseverance, self-confidence, and reflective abilities in problem-solving. The development of technical, logical, and analytical competencies, accompanied by flexibility in strategy selection, is essential for building a strong mathematical identity. A deep understanding of mathematical concepts, coupled with the ability to reflect and evaluate one’s work, has been

shown to enhance accuracy and efficiency in problem-solving. Therefore, classroom practices should adopt approaches that support reflective thinking skills and provide opportunities for students to test and verify the strategies they choose. Future research could focus on developing flexible and creative learning strategies, improving reflective techniques to help students systematically correct errors, and involving more diverse samples to test the consistency of findings. Additionally, implementing problem-based learning relevant to real-life contexts is expected to strengthen students' mathematical identity and improve their ability to solve problems efficiently and accurately.

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