



ANALYSIS OF STUDENTS' MISCONCEPTIONS ON PRIME NUMBERS BASED ON THE CERTAINTY OF RESPONSE INDEX (CRI)

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Diterima: 4/4/2026; Direvisi: 8/4/2026; Diterbitkan: 19/4/2026

ABSTRAK

Miskonsepsi merupakan salah satu permasalahan yang sering muncul dalam pembelajaran matematika dan dapat menghambat pemahaman konsep siswa. Pada materi bilangan prima, kesalahan pemahaman sering terjadi karena siswa belum sepenuhnya memahami definisi dan karakteristik faktor suatu bilangan. Oleh karena itu, diperlukan identifikasi yang sistematis untuk mengetahui bentuk miskonsepsi yang dialami siswa. Penelitian ini bertujuan untuk menganalisis miskonsepsi siswa pada materi bilangan prima dengan menggunakan metode *Certainty of Response Index* (CRI). Penelitian ini menggunakan pendekatan kuantitatif dengan jenis penelitian deskriptif. Subjek penelitian adalah 23 siswa kelas IX di SMP Deli Murni Sukamaju. Data dikumpulkan melalui tes diagnostik sebanyak 15 soal yang dilengkapi dengan skala CRI untuk mengukur tingkat keyakinan siswa terhadap jawaban yang diberikan. Data dianalisis dengan mengelompokkan respons siswa berdasarkan ketepatan jawaban dan tingkat keyakinan, kemudian diklasifikasikan ke dalam empat kategori pemahaman, yaitu memahami konsep, miskonsepsi, tidak memahami konsep, dan menebak. Hasil penelitian menunjukkan bahwa dari 345 respons siswa, sebesar 31,6% termasuk kategori memahami konsep, 39,1% mengalami miskonsepsi, 20,9% tidak memahami konsep, dan 8,4% menjawab dengan menebak. Miskonsepsi yang dominan berkaitan dengan definisi bilangan prima, penentuan faktor bilangan, serta anggapan bahwa semua bilangan ganjil adalah bilangan prima. Temuan ini menunjukkan bahwa metode CRI efektif untuk mengidentifikasi miskonsepsi siswa sehingga dapat menjadi dasar bagi guru dalam merancang pembelajaran yang lebih menekankan pada pemahaman konsep.

Kata Kunci: *Miskonsepsi, Bilangan Prima, CRI, Tes Diagnostik, Pemahaman Konsep*

ABSTRACT

Misconceptions are one of the common problems in mathematics learning and can hinder students' conceptual understanding. In the topic of prime numbers, misunderstandings often occur because students do not fully comprehend the definition and characteristics of the factors of a number. Therefore, a systematic identification is needed to determine the types of misconceptions experienced by students. This study aims to analyze students' misconceptions on the topic of prime numbers using the *Certainty of Response Index* (CRI) method. This study employed a quantitative approach with a descriptive research design. The research subjects were 23 ninth-grade students at SMP Deli Murni Sukamaju. Data were collected through a diagnostic test consisting of 15 questions equipped with a CRI scale to measure students' confidence in their answers. The data were analyzed by grouping students' responses based on answer accuracy and confidence level, which were then classified into four categories of understanding: conceptual understanding, misconception, lack of understanding, and guessing.





The results showed that out of 345 student responses, 31.6% were categorized as understanding the concept, 39.1% experienced misconceptions, 20.9% did not understand the concept, and 8.4% answered by guessing. The dominant misconceptions were related to the definition of prime numbers, determining the factors of a number, and the assumption that all odd numbers are prime numbers. These findings indicate that the CRI method is effective in identifying students' misconceptions and can serve as a basis for teachers to design learning strategies that emphasize conceptual understanding.

Keywords: *Misconceptions, Prime Numbers, CRI, Diagnostic Test, Conceptual Understanding*

INTRODUCTION

Misconceptions remain one of the most persistent challenges in mathematics education and often interfere with the development of students' conceptual understanding. In mathematics learning, students sometimes produce incorrect answers while expressing high confidence in their responses, indicating that the errors are rooted in conceptual misunderstandings rather than simple calculation mistakes. Such conditions occur when the cognitive structures developed by students differ from the scientifically accepted concepts taught in formal education. As a result, misconceptions can become deeply embedded in students' thinking and may continue to influence their reasoning processes when solving mathematical problems (Putri & Subekti, 2021; Putri et al., 2024). If these misconceptions are not identified early, they can hinder the development of deeper mathematical reasoning and limit students' ability to connect related mathematical ideas effectively.

Conceptual understanding is widely recognized as a fundamental component of meaningful mathematics learning because it enables students to interpret mathematical relationships, apply procedures appropriately, and construct logical reasoning. When misconceptions arise, they may disrupt the coherence of students' knowledge structures and influence their ability to understand related concepts. Previous studies have shown that students' conceptual development is influenced by several factors, including learning experiences, mathematical disposition, and the instructional strategies implemented in the classroom (Febriyani et al., 2022; Kriswinarso et al., 2023). In situations where teaching practices emphasize procedural memorization rather than conceptual exploration, students are more likely to develop incomplete or inaccurate conceptual interpretations. Therefore, identifying misconceptions at an early stage is essential so that educators can design learning environments that support deeper conceptual understanding.

Research in mathematics education has consistently reported the presence of misconceptions across different mathematical topics and educational levels. A number of studies indicate that misconceptions often arise from incomplete reasoning, overgeneralization of patterns, or ineffective instructional approaches that fail to emphasize conceptual clarity (Putri et al., 2024; Dahlan & Saharuddin, 2026). In addition, several cognitive and pedagogical factors may contribute to the emergence of misconceptions, including students' prior knowledge, learning habits, and the way mathematical concepts are introduced during instruction (Hamid, 2025). These findings demonstrate that misconceptions represent a systematic issue in mathematics learning rather than isolated errors made by individual students. Consequently, understanding the patterns and sources of misconceptions is necessary to improve the effectiveness of mathematics instruction.

Empirical research conducted in Indonesia also shows that misconceptions among students remain relatively prevalent. Studies analyzing students' responses using the Certainty



of Response Index (CRI) method reveal that many students provide incorrect answers while still demonstrating a high level of confidence in their responses (Apriyanto et al., 2022). Similar results have been found in research involving elementary school students, where CRI analysis successfully distinguished between conceptual misunderstanding and answers produced through guessing (Sinaga et al., 2024). These findings highlight the importance of diagnostic assessments that can reveal not only the correctness of students' answers but also their level of confidence. Through such diagnostic approaches, teachers can gain a deeper understanding of the nature of students' conceptual difficulties and provide more appropriate instructional interventions.

Various diagnostic tools have been developed to identify misconceptions more accurately in mathematics and science education. Among these tools, multi-tier diagnostic assessments combined with the Certainty of Response Index have gained considerable attention because they allow researchers to analyze both the accuracy of students' answers and their confidence levels. This approach enables responses to be classified into several categories, including conceptual understanding, misconceptions, lack of understanding, and guessing (Putri & Subekti, 2021; Maulida et al., 2023). Furthermore, the CRI method has been applied in different scientific disciplines to identify misconceptions more comprehensively by integrating cognitive and affective aspects of students' responses (Putri et al., 2022). Research conducted by Mellu et al. (2022) also demonstrates that diagnostic tests integrated with CRI can effectively reveal the underlying causes of misconceptions by analyzing the relationship between students' reasoning processes and their confidence levels. These findings indicate that CRI-based diagnostic methods provide valuable insights for understanding the complexity of students' conceptual errors.

From a broader perspective, misconceptions in mathematics may appear in different forms, such as incorrect reasoning, misunderstandings of mathematical definitions, and confusion between closely related concepts. These misconceptions often emerge because students construct knowledge based on incomplete interpretations of mathematical ideas or rely on superficial patterns when solving problems. Research on mathematical misconceptions suggests that students frequently misinterpret mathematical relationships or apply inappropriate reasoning strategies when confronted with unfamiliar tasks (Kurudirek et al., 2025). As a result, incorrect conceptual structures may persist and influence students' future learning experiences. Therefore, exploring the nature of misconceptions is essential for improving the design of mathematics instruction.

One mathematical topic that frequently leads to misconceptions is the concept of prime numbers. Although prime numbers represent a fundamental idea in number theory, students often experience difficulties when interpreting their definitions and characteristics. Previous studies examining mathematics textbooks have shown that ambiguous explanations or incomplete presentations of the concept of prime numbers may contribute to misunderstandings among students (Ramadany et al., 2025). For example, students sometimes misunderstand the role of the number one, encounter difficulties when identifying factors of numbers, or incorrectly assume that all odd numbers are prime numbers. These conceptual challenges indicate that students' understanding of prime numbers may not always align with the formal mathematical definition.

Although many studies have explored the use of the Certainty of Response Index in identifying misconceptions in mathematics learning, research specifically focusing on misconceptions related to prime numbers is still relatively limited. Most existing studies tend



to examine misconceptions in topics such as algebraic operations, exponents, or numerical computations, leaving a gap in the literature regarding the application of CRI in the context of prime numbers. Considering the conceptual characteristics of prime numbers, misconceptions in this topic may have unique patterns that differ from those found in other mathematical domains. Therefore, this study aims to analyze students' misconceptions related to prime numbers using the Certainty of Response Index method. The findings are expected to provide empirical evidence that contributes to a deeper understanding of students' conceptual difficulties and supports the development of more effective mathematics learning strategies.

RESEARCH METHOD

This study applied a descriptive quantitative research design to identify students' misconceptions regarding the concept of prime numbers. The participants were 23 ninth-grade students from SMP Deli Murni Sukamaju who were selected using purposive sampling based on their participation in the mathematics learning process during the study period. The total data analyzed in this research consisted of 345 responses, which were obtained from students' answers to all items in the diagnostic test. This design was chosen to provide a systematic description of the distribution of students' conceptual understanding and misconceptions related to prime numbers.

The research instrument was a diagnostic test consisting of 15 multiple-choice questions designed to assess students' understanding of the concept of prime numbers. Each item was accompanied by a Certainty of Response Index (CRI) scale, requiring students to indicate their level of confidence in the selected answer. In this approach, responses were interpreted by combining answer accuracy and confidence level: correct answers with high confidence indicate sound conceptual understanding, while incorrect answers with high confidence reflect misconceptions. Meanwhile, correct answers with low confidence suggest partial understanding, and incorrect answers with low confidence are categorized as guessing. This classification enables a more precise identification of students' conceptual status beyond conventional right-wrong scoring. Prior to its use in the study, the instrument was reviewed by mathematics education experts to ensure the relevance and clarity of the test items in measuring students' conceptual understanding of prime numbers.

Data collection was conducted by administering the diagnostic test directly to students during the mathematics learning session. After completing each question, students were asked to indicate their confidence level using the CRI scale provided with the test items. The collected responses were analyzed by considering both the correctness of the answers and the confidence levels expressed by the students. Based on these two indicators, each response was classified into four categories: conceptual understanding, misconception, lack of conceptual understanding, and guessing. The number of responses in each category was then calculated and presented in percentage form to describe the overall distribution of students' conceptual understanding related to the concept of prime numbers.

RESULT AND DISCUSSION

Result

The results of this study were obtained from the analysis of students' responses to a diagnostic test on prime numbers. The instrument consisted of 15 questions answered by 23 ninth-grade students, resulting in a total of 345 responses. Each response was evaluated using the Certainty of Response Index (CRI) to identify both the correctness of the answer and the

confidence level expressed by students. Through this analysis, students' responses were grouped into four categories: conceptual understanding, misconception, lack of conceptual understanding, and guessing. The overall distribution of students' conceptual understanding based on the CRI analysis is presented in Table 1.

Table 1. Distribution of Students' Conceptual Understanding Based on CRI Analysis

Category	Number of Responses	Percentage (%)
Conceptual understanding	109	31.6
Misconception	135	39.1
Lack of conceptual understanding	72	20.9
Guessing	29	8.4
Total	345	100

Table 1 shows that the misconception category represents the largest proportion of student responses, reaching 39.1% of the total responses. This indicates that a considerable number of students provided incorrect answers while expressing confidence in their responses. Meanwhile, 31.6% of responses were categorized as conceptual understanding, meaning that students answered correctly and were confident about their answers. The remaining responses were classified as lack of conceptual understanding (20.9%) and guessing (8.4%), which reflects that some students were uncertain about the concepts being assessed. To provide a clearer illustration of the distribution of students' conceptual understanding categories, the percentage comparison among the four categories is presented in Figure 1.

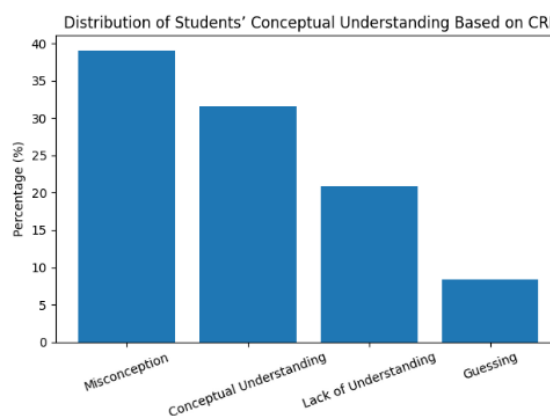


Figure 1. Distribution of Students' Conceptual Understanding Based on CRI

Figure 1 illustrates that misconceptions dominate students' responses compared with the other categories. The proportion of misconceptions is higher than the proportion of students who correctly understand the concept. This pattern suggests that many students believe they understand the concept even though their answers indicate otherwise. Such conditions highlight

the importance of identifying misconceptions during the learning process. A more detailed analysis was also conducted to identify the types of misconceptions that appeared in students' answers related to the concept of prime numbers. The classification of several common misconception patterns found in students' responses is summarized in Table 2.

Table 2. Types of Students' Misconceptions on Prime Numbers

Type of Misconception	Description
Misunderstanding the definition of prime numbers	Students do not recognize that prime numbers must have exactly two factors
Difficulty identifying number factors	Students cannot correctly determine the factors of a number
Generalization of odd numbers	Students assume that all odd numbers are prime numbers
Incorrect reasoning	Students explain prime numbers using irrelevant criteria

Table 2 indicates that misconceptions occur in several conceptual aspects related to prime numbers. One of the most common misunderstandings concerns the definition of prime numbers, where some students fail to recognize that a prime number has exactly two factors. In addition, several students experience difficulty when determining the factors of a number, which leads to errors when identifying whether a number is prime or composite. Another misconception observed is the tendency to assume that all odd numbers are prime numbers, indicating that students often rely on incomplete patterns when forming mathematical conclusions.

Overall, the findings of this study demonstrate that misconceptions related to prime numbers are still relatively prevalent among students. These misconceptions mainly arise from incomplete conceptual understanding and incorrect generalizations formed during the learning process. Identifying these patterns of misunderstanding is important so that teachers can design learning strategies that emphasize conceptual clarity. By strengthening students' understanding of number factors and the definition of prime numbers, the occurrence of misconceptions in mathematics learning can be reduced.

Discussion

The results of this study indicate that misconceptions about prime numbers remain relatively common among students. The high percentage of responses categorized as misconceptions shows that some students are confident in their answers even though their understanding of the concept is incorrect. This situation suggests that the errors made by students are not merely caused by a lack of knowledge but rather by inaccurate conceptual construction. Misconceptions in mathematics learning often occur when students develop an incomplete understanding of mathematical concepts, which can lead to persistent errors in problem solving (Putri et al., 2024).



Students' misconceptions are frequently associated with weak conceptual understanding of fundamental mathematical ideas. In this study, many students showed difficulty in identifying the characteristics of prime numbers, particularly the concept that a prime number must have exactly two factors. When students fail to understand the concept of number factors, they may struggle to determine whether a number is prime or composite. Similar findings were reported by Apriliyana et al. (2023), who explained that limited conceptual understanding can significantly affect students' ability to apply mathematical concepts correctly.

One of the misconception patterns identified in this study is the tendency of students to assume that all odd numbers are prime numbers. This assumption likely arises because many examples of prime numbers presented during instruction are odd numbers. However, when students rely on examples without understanding the underlying mathematical concept, they may develop incorrect generalizations. Previous research also shows that misconceptions in mathematics often occur when students generalize patterns without a comprehensive conceptual understanding (Peni, 2025).

Students' errors in solving mathematical problems are also closely related to their reasoning processes. In several cases, students provided explanations that were not relevant to the concept of number factors when asked to justify why a number is not prime. This finding indicates that some students rely on superficial reasoning rather than conceptual understanding when responding to mathematical questions. Similar patterns were observed in previous studies, which found that students' incorrect answers are often influenced by weaknesses in mathematical reasoning and critical thinking (Ronny et al., 2022).

Learning difficulties can also contribute to the emergence of misconceptions in mathematics. Some students may encounter challenges when interpreting mathematical problems because they do not fully understand the underlying concepts. Research conducted by Hijriah et al. (2023) shows that students often experience difficulties when solving mathematical problems due to limited conceptual comprehension. In addition, learning obstacles in mathematics can arise from various factors, including cognitive challenges, instructional approaches, and learning environments (Husna et al., 2022).

From a broader perspective, students' misconceptions in mathematics have been widely discussed in educational research. A systematic literature review conducted by Suhendra et al. (2025) highlights that many mathematical errors originate from incomplete conceptual understanding and ineffective instructional strategies. Diagnostic approaches such as the four-tier diagnostic test can help educators identify misconceptions more accurately and systematically (Al-Qonuni & Afriansyah, 2023). Identifying misconceptions is therefore essential for improving the quality of mathematics learning and preventing persistent conceptual errors among students.

Addressing students' misconceptions requires instructional strategies that emphasize conceptual understanding rather than procedural memorization. Teachers should provide opportunities for students to explore mathematical concepts through meaningful learning activities that encourage reasoning and reflection. Innovative approaches, such as integrating ethnomathematics into classroom instruction, have been shown to enhance students' engagement and deepen their understanding of mathematical concepts (Khaerani et al., 2024). In addition, teachers' awareness of students' misconceptions plays an important role in guiding students toward accurate conceptual understanding (Moosapoor, 2023).



CONCLUSION

The findings of this study indicate that students' conceptual understanding of prime numbers is still varied and not yet fully developed. The analysis using the Certainty of Response Index (CRI) method reveals that although some students demonstrate correct conceptual understanding, a considerable number of students still experience misconceptions and incomplete comprehension of the concept. This condition suggests that errors in identifying prime numbers are not only caused by a lack of knowledge but also by inaccurate conceptual interpretations formed during the learning process. Therefore, identifying students' misconceptions is an important step in understanding the actual level of students' conceptual mastery in mathematics learning.

The results of this study also emphasize the importance of using diagnostic assessments to reveal students' conceptual difficulties more accurately. The CRI method provides valuable information regarding the relationship between the correctness of students' answers and their confidence levels, allowing teachers to distinguish between students who truly understand the concept and those who hold misconceptions. Through this approach, educators can obtain a clearer picture of the patterns of misunderstanding experienced by students. Consequently, mathematics instruction should prioritize the development of conceptual understanding so that students can build correct and meaningful mathematical knowledge.

In addition, the findings of this study provide important implications for improving mathematics learning practices in schools. Teachers are encouraged to design learning activities that emphasize conceptual exploration, reasoning, and meaningful problem solving to reduce the occurrence of misconceptions among students. Future research may further explore the application of diagnostic methods in different mathematical topics or educational levels to obtain a broader understanding of students' conceptual difficulties. Such studies are expected to contribute to the development of more effective learning strategies that support students in achieving deeper conceptual understanding in mathematics.

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