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AN ANALYSIS OF STUDENTS' MISCONCEPTIONS ON NEWTON'S LAWS USING THE CERTAINTY OF RESPONSE INDEX (CRI) METHOD IN CLASS IX-B OF SMAN 2 PERCUT SEI TUAN

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Abstract

Misunderstanding of Newton's Laws is one of the main factors contributing to low physics achievement at the senior high school level. These misconceptions are often stable and strongly believed by students, which can hinder further learning, making early identification an important step for improving instruction. This study aims to describe students' levels of conceptual understanding and misconceptions regarding Newton's Laws using a diagnostic test based on the Certainty of Response Index (CRI). The research was conducted with 33 tenth-grade students from class X-B at SMA Negeri 2 Percut Sei Tuan using a descriptive quantitative non-experimental design. The instrument consisted of 10 multiple-choice questions accompanied by a CRI scale ranging from 1 to 5, which was used to classify students into categories of understanding the concept, not understanding the concept, lucky guess, and misconception. Data were analyzed based on the combination of correct/incorrect answers and high/low CRI scores. The results indicate that students still experience significant misconceptions in several sub-concepts, particularly concerning action–reaction forces, the identification of forces acting on an object, and the relationship between net force and motion. These misconceptions primarily appear among students who are highly confident in their incorrect answers , with the highest percentage of misconceptions found on Question No. 5 at 72.8%, followed by Questions No. 3 and No. 7, each reaching 57.6%. These findings confirm that the CRI method is effective in diagnosing the quality of student understanding and highlights the need for instructional interventions that focus on correcting faulty conceptual beliefs rather than merely procedural memorization.

Keywords:
Newton's Laws
Misconceptions
Certainty of Response Index (Cri) Conceptual Understanding
Diagnostic Test

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INTRODUCTION

Conceptual understanding is a fundamental component of learning physics, as most physical phenomena can only be comprehended through the ability to connect abstract concepts with real-world events in the environment (Danielson et al., 2025). However, various studies show that students often do not understand concepts as they are scientifically defined. Many of them construct knowledge based on intuition, daily experiences, or incomplete reasoning, which leads to understandings that deviate from the actual concepts commonly known as misconceptions (Isra & Mufit, 2023; Huda et al., 2022; Winarti et al., 2021).

Misconceptions are not merely momentary errors, but rather stable and consistent patterns of thinking that can hinder students from learning more advanced material (Suparno, 2013; Putri et al., 2022). In the topic of Newton's Laws, misconceptions appear more frequently than in other mechanics topics. Students often make mistakes in explaining forces, action reaction pairs, interpreting motion, and understanding the relationship between net force and acceleration (Isra & Mufit, 2023; Winarti et al., 2021). For example, students often believe that a larger object must exert a greater force during a collision, or assume that the normal force and gravitational force are an action reaction pair even though they originate from different interactions.

Previous studies have reported relatively high levels of misconceptions, ranging from 20 - 40% across different educational levels (Isra & Mufit, 2023; Huda et al., 2022), and even exceeding 44% on certain indicators (Azahra & Wasis, 2024). The causes of these misconceptions are varied, including students' preconceptions, inaccurate explanations from teachers, the use of misleading analogies, and incorrect interpretations of textbooks (Huda et al., 2022; Winarti et al., 2021).

Therefore, identifying misconceptions becomes a crucial step before determining suitable intervention strategies. Various instruments have been developed, such as two-tier, three-tier, four-tier, and even five-tier diagnostic tests (Isra & Mufit, 2023). One instrument widely used in studies at the high school level is the Certainty of Response Index (CRI), as it can distinguish whether an incorrect answer arises from a lack of knowledge or from a confidently held misunderstanding. The use of CRI allows researchers to classify students' understanding into categories such as understanding the concept, not understanding the concept, lucky guess, and misconception (Purwanto et al., 2025).

In the context of high school physics learning, identifying the level of misconceptions related to Newton's Laws is essential so that teachers can design appropriate instructional strategies and prevent these misconceptions from carrying over to higher levels of education. By conducting an analysis based on diagnostic tests and CRI, this study aims to describe the real condition of high school students' understanding of Newton's Laws and the factors that influence it.

RESEARCH METHOD

This study was conducted at SMA Negeri 2 Percut Sei Tuan, located on Jl. Pendidikan, Bandar Klippa, Percut Sei Tuan District, Deli Serdang Regency, North Sumatra, involving class X-B with a total of 33 students. Data collection took place on November 11, 2025 through the administration of a diagnostic test on Newton's Laws.

The type of research used was descriptive quantitative non-experimental research, which aims to describe the actual conditions related to students' levels of understanding and misconceptions without applying any specific treatment. The study focused on depicting students' misconceptions about Newton's Laws based on a diagnostic test accompanied by the Certainty of ResponseIndex (CRI).

The main instrument in this research was a diagnostic test consisting of 10 multiple-choice questions covering the fundamental concepts of Newton's Laws (First, Second, and Third Laws, forces acting on objects, and their applications). Each question was equipped with a Certainty of Response Index (CRI) scale ranging from 1 to 5, which was used to measure students' confidence in their chosen answers. The meaning of the CRI scale used is presented in

Table 2.1. Table 2.1. CRI Scale and Criteria

CRI	Criteria
1	Don't know
2	Not Sure
3	Unsure
4	Sure
5	Very Sure

Research data was collected by administering diagnostic tests directly to all students in class X-B. Students were asked to select answers to each question and determine their level of confidence using the CRI scale. Test results were analysed to identify categories of student understanding based on a combination of correct/incorrect answers and CRI levels.

Student comprehension categories were determined based on a combination of correct/incorrect answers and CRI confidence levels. In this study, CRI scores ranged from 1 to 5, so the confidence category thresholds were set as follows:

CRI	**Index Scale**
Low	1-2
High	3-5

With these limitations, students' understanding categories are grouped as follows:

1. Understanding the concept = correct answer with high CRI (CRI 3-4)
2. Misconception = incorrect answer with high CRI (CRI 3-4)
3. No understanding of the concept = incorrect answers with low CRI (CRI 1-2)
4. Lucky guess = correct answers with low CRI (CRI 1-2)

Data analysis was conducted by calculating the number of students in each category, then calculating the percentage of the total number of students using the following formula:

$$Persentase = \frac{Number\ Of\ Students\ In\ A\ Particular\ Category}{33} \times 100\%$$

The results of the analysis are presented descriptively to illustrate the level of students' misconceptions on each subconcept of Newton's Laws.

RESULTS AND DISCUSSION

CRI Analysis Results

The data from the analysis using the CRI method is presented in the form of a table of the percentage of students' level of understanding for each question item (1-10).

Table 1: Percentage of Student Comprehension Levels Based on CRI Analysis

No Questions	Do Not Understand the Concept(%)	Understand the Concept(%)	Misconceptions(%)	Guessing(%)
1	6.7%	51.5%	39.4%	3.1%
2	12.2%	51.5%	24.3%	9.1%
3	18.2%	12.2%	57.6%	12.2%
4	27.3%	42.5%	24.3%	9.1%
5	18.2%	9.10%	72.8%	3.1%
6	33.3%	15.2%	48.5%	0%
7	15.2%	27.3%	57.6%	0%
8	9.4%	37.5%	28.2%	28.2%
9	6.3%	65.7%	9.4%	9.1%
10	28.2%	43.8%	3.2%	3.1%

Discussion

Based on Table 1 and the graph of Student Understanding Levels for Each Question Item (1-10), it can be seen that the percentage of misconceptions dominates in several questions, indicating the existence of a flawed knowledge structure that is deeply ingrained in students.

The three questions with the highest percentage of misconceptions are:

1. **Question No. 5:** Achieved the highest percentage of misconceptions, namely **72.8%.**
2. **Questions No. 3** and No. 7: Each had a high percentage of misconceptions, namely **57.6%.**

The high number of misconceptions in these questions shows that students tend to still use everyday intuitive understanding (such as the assumption that 'force is needed to maintain motion') that contradicts the principles of physics, particularly Newton's First Law (Inertia) and Newton's Second Law. For example, questions such as "A ball is moving on a smooth floor. There is no longer any force pushing it. What will happen?' are often answered incorrectly because students still hold on to the assumption that an object will stop if there is no pushing force acting on it, ignoring the ideal condition of a 'slippery floor" (zero/negligible friction force), which is in accordance with Newton's First Law.

Conversely, the highest percentage of Conceptual Understanding was found in Question No. 9 (65.7%) and Questions No. 1 and 2 (51.5% each).

CONCLUSION

Based on data analysis using the Certainty of Response Index (CRI) method, it can be concluded that students' conceptual understanding of Newton's Laws is largely characterised by significant misconceptions rather than simply a lack of knowledge. This is evidenced by the high percentage of misconceptions on certain items, particularly on item number 5 (72.8%), as well as items number 3 and 7 (57.6%).

These findings indicate that the majority of students are still trapped in daily intuitions that contradict the principles of physics regarding the interaction of force and motion. This study confirms that the CRI method is effective in diagnosing the quality of students' understanding and shows that the main obstacle to learning is not a lack of study, but rather the strength of students' beliefs in initial misconceptions.

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