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Profile of Students' Misconception Levels on Newton's Laws Using a Six-Tier Diagnostic Test

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Abstract. Conceptual understanding is a fundamental foundation in physics learning; however, numerous studies have reported that students continue to hold misconceptions that are resistant to formal instruction. One topic that is particularly prone to misconceptions is Newton's Laws, which serve as a basis for understanding more advanced physics concepts. This study aims to profile students' levels of misconceptions on Newton's Laws based on diagnostic results obtained using a six-tier diagnostic test. This research employed a quantitative descriptive approach with a survey design. The participants were 132 eleventh-grade students from SMAN 2 Cikampek, selected through purposive sampling. The instrument used was a six-tier diagnostic test covering three sub-concepts of Newton's Laws and analyzed based on combinations of students' answers, conceptual reasoning, confidence levels, and sources of reasoning. The results indicate that although the sound understanding category showed the highest percentage (43.99%), more than half of the students were still classified as having problematic understanding, particularly misconceptions and negative errors. Misconceptions were consistently identified across all three sub-concepts of Newton's Laws with a cumulative pattern, where the highest level of misconception occurred in Newton's Third Law, especially in understanding action–reaction force pairs. From the perspective of misconception sources, students' misconceptions were predominantly derived from internal cognitive constructions based on intuition and everyday experiences. These findings emphasize that instruction on Newton's Laws should focus on eliciting and reconstructing students' prior conceptual understanding in an integrated manner, so that persistent misconceptions can be reduced and students' conceptual understanding can be improved.

Keywords: misconceptions, Newton's laws, six-tier diagnostic test, conceptual understanding, physics education

1. Introduction

Conceptual understanding is a fundamental foundation in physics learning [1]. However, in practice, many students are still unable to comprehend scientific concepts accurately [1,2]. One persistent issue that frequently arises is the presence of misconceptions [3,4]. Misconceptions refer to incorrect or alternative conceptions held by students that differ from scientifically accepted explanations and tend to be resistant to change even after formal instruction [5,6]. Unlike a lack of knowledge, misconceptions involve firmly held beliefs in which students are confident that their understanding is correct, even though it contradicts scientific concepts [7]. This condition poses a serious challenge in physics education, as misconceptions can negatively affect students' ability to connect concepts, solve problems, and develop scientific thinking skills [5,8].

Newton's laws constitute one of the fundamental topics in physics, serving as the foundation for understanding more advanced concepts such as motion, momentum, work and energy, and rotational dynamics [9]. Nevertheless, numerous studies have reported that this topic is highly prone to misconceptions due to its abstract nature and the strong logical reasoning it requires [10–12]. Commonly identified misconceptions include the belief that a stationary object experiences no force or that forces act only when an object is in motion [13,14], misunderstandings regarding the relationship between force, mass, and acceleration in Newton's Second Law [15,16], as well as the assumption that action–reaction force pairs in Newton's Third Law act on the same object and cancel each other out [17,18].

The high prevalence of misconceptions related to Newton's laws has also been demonstrated quantitatively. Several studies have reported that the percentage of students experiencing misconceptions on this topic ranges from 39% to more than 89% [19–21]. Students tend to rely heavily on intuition when solving physics problems and often experience difficulties in understanding force interactions between objects, particularly when differences in mass are involved [22,23]. Misconceptions accompanied by a high level of confidence make these conceptual errors resistant to change through conventional instruction, highlighting the need for systematic and accurate diagnostic identification.

One important initial step in addressing misconceptions is the use of diagnostic instruments [24]. Over time, diagnostic tests have evolved from two-tier to five-tier formats; however, these instruments still have limitations in comprehensively revealing students' depth of understanding and levels of confidence. The six-tier diagnostic test has emerged as a more informative alternative, as it not only assesses students' answers and conceptual reasoning but also examines their confidence levels and the sources underlying their responses [25]. Consequently, this instrument enables a more in-depth and accurate diagnosis of students' misconceptions.

Nevertheless, studies that specifically profile students' levels of misconceptions on Newton's laws using a six-tier diagnostic instrument remain relatively limited. Therefore, this study aims to present a profile of students' misconception levels on Newton's laws based on diagnostic results obtained through a six-tier diagnostic test. The findings of this study are expected to provide empirical insights into the levels and distribution of students' misconceptions, which may serve as a foundation for designing physics instruction that is more oriented toward conceptual understanding.

2. Method

This study employed a quantitative descriptive approach. The research was conducted without providing any specific instructional treatment to the students and aimed to profile students' levels of misconceptions on Newton's laws as part of their existing conceptual understanding after completing formal instruction.

The research participants were eleventh-grade students from SMAN 2 Cikampek who had studied Newton's laws. The sample was selected using purposive sampling, based on the considerations that the students had received instruction related to Newton's laws and that the school had not previously been involved in studies on misconceptions of Newton's laws using a six-tier diagnostic instrument. Based on these criteria, a total of 132 students from four Grade XI classes were included as the research sample.

The research instrument used was a six-tier diagnostic test designed to identify students' misconceptions on Newton's laws. The instrument consists of six components: (1) students' responses to conceptual questions, (2) confidence levels in the given responses, (3) the conceptual reasoning provided by students, (4) confidence levels in the given reasoning, (5) confidence in the consistency between the responses and the reasoning, and (6) the sources used by students in answering the questions. The six-tier diagnostic test covers three sub-concepts of Newton's laws, namely Newton's First Law, Newton's Second Law, and Newton's Third Law, and was developed based on the learning outcomes of the Kurikulum Merdeka. An example of a six-tier diagnostic test item used in this study is presented in Table 1.

Prior to its implementation, the six-tier diagnostic instrument underwent a calibration process to ensure its feasibility and quality. Instrument calibration was conducted through expert judgment evaluation and a pilot test. The results of the expert judgment evaluation indicated that the instrument was categorized as very good across all assessed aspects, as presented in Table 2.

Table 1. Example of a six-tier diagnostic test item.

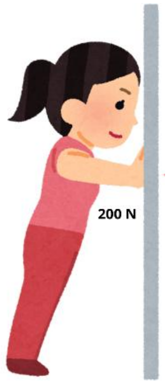
Tier	Description	Example
Tier 1	Conceptual question	A student pushes a wall with a force of 200 N, but the wall does not move at all.  Based on Newton's Third Law, which statement is the most appropriate? A. The wall does not exert a reaction force because it does not move. B. The wall exerts a reaction force toward the student. C. The wall only resists the pressure without exerting a reaction force toward the student. D. There is no force at all because no displacement occurs.
Tier 2	Confidence in answer	Are you confident in your answer? - Confident - Not confident
Tier 3	Reasoning	What is the reason for the answer you selected in Tier 1? When a student pushes a wall with a force of 200 N, the wall's lack of motion does not mean that no reaction force exists. According to Newton's Third Law, every action force is always accompanied by an equal and opposite reaction force. Therefore, the wall exerts a reaction force of 200 N on the student. This means that the action–reaction force pair still exists even though no displacement occurs.
Tier 4	Confidence in reasoning	Are you confident in your reasoning? - Confident - Not confident
Tier 5	Confidence in answer–reasoning consistency	Are you confident that there is a causal relationship between your answer and your reasoning? - Confident - Not confident
Tier 6	Source of answer	What is the primary source of your knowledge when answering this question? - Self-generated reasoning - Textbook - Peer discussion - Teacher explanation - Other:…

Table 2. Results of expert judgment evaluation.

Aspect	Value	Category
Content	0.95	Very good
Construct	0.97	Very good
Language	0.98	Very good

Following the validity testing, a reliability test was conducted to examine the internal consistency of the instrument. The reliability test yielded a reliability coefficient categorized as high, indicating that the instrument demonstrated strong consistency in identifying students' misconceptions. The results of the reliability test are presented in Table 3.

Table 3. Results of the reliability test.

Reliability Value	Reliability Criterion
0.884	High

After ensuring the reliability of the instrument, the students' responses were analyzed by categorizing combinations of answers, reasoning, and confidence levels into several categories of conceptual understanding. These categories include sound understanding, misconception, lack of understanding, negative error, and positive error. The classification of students' conceptual understanding based on the combination of responses in the six-tier diagnostic test is presented in Table 4.

Table 4. Classification of conceptual understanding based on six-tier response combinations.

1st Tier	2nd Tier	3rd Tier	4th Tier	5th Tier	Category		6th Tier	Description
1	C	1	C	C	SU	+	TB P SR T O	1 "Correct" 0 "Incorrect" C "Confident" UC "Not Confident" TB "Textbook" T "Teacher" SR "Self Reasoning" P "Peer" O "Others" SU "Sound Understanding" LU "Lack of Understanding" PE "Positive Error" NE "Negative Error" M "Misconception"
1	C	1	C	UC	LU			
1	C	1	UC	C				
1	C	1	UC	UC				
1	UC	1	C	C				
1	UC	1	C	UC				
1	UC	1	UC	C				
1	UC	1	UC	UC				
1	C	0	C	C	PE			
1	C	0	C	UC	LU			
1	C	0	UC	C				
1	C	0	UC	UC				
1	UC	0	C	C				
1	UC	0	C	UC				
1	UC	0	UC	C				
1	UC	0	UC	UC				
0	C	1	C	C	NE			
0	C	1	C	UC	LU			
0	C	1	UC	C				
0	C	1	UC	UC				
0	UC	1	C	C				
0	UC	1	C	UC				
0	UC	1	UC	C				
0	UC	1	UC	UC				
0	C	0	C	C	M			
0	C	0	C	UC	LU			
0	C	0	UC	C				
0	C	0	UC	UC				
0	UC	0	C	C				
0	UC	0	C	UC				
0	UC	0	UC	C				
0	UC	0	UC	UC				

Subsequently, students' misconception levels were analyzed quantitatively using percentages to describe the proportion of students in each conceptual understanding category. The percentage for each category was calculated using the following equation

$$P = \frac{f}{N} \times 100\% \quad (1)$$

where P represents the percentage of a given category, f is the number of students in that category, and N is the total number of students. The criteria for students' misconception levels based on percentage results are presented in Table 5.

Table 5. Categories of percentage-based results [26].

Percentage	Category
0-33%	Low
34-66%	Moderate
67-100%	High

The categorized data were then used to calculate the percentage of students in each category for every test item and sub-concept of Newton's laws. The results were used to describe the profile and distribution of students' misconception levels.

3. Results and Discussion

In this study, the analyzed data consisted of students' response data obtained from the six-tier diagnostic instrument used to identify misconceptions on Newton's laws. The six-tier instrument provides detailed information regarding students' levels of conceptual understanding, as examined through the accuracy of their answers, the conceptual reasoning provided, and their levels of confidence in the given responses. The results of the six-tier diagnostic test analysis reveal the distribution of students' conceptual understanding categories on Newton's laws, as presented in Table 6.

Table 6. Distribution of students' conceptual understanding categories on Newton's laws.

Conceptual Understanding Category	Percentage	Description
Sound understanding	43.99%	Moderate
Lack of understanding	12.98%	Low
Misconception	21.39%	Low
Negative error	16.82%	Low
Positive error	4.82%	Low

Based on the overall distribution of students' conceptual understanding categories, the sound understanding category exhibited the highest percentage, at 43.99%. This finding indicates that nearly half of the students had developed an appropriate understanding of the fundamental concepts of Newton's laws. Nevertheless, this percentage cannot yet be considered optimal, as more than half of the students were still classified within problematic understanding categories, including misconceptions, negative errors, lack of understanding, and positive errors. This condition suggests that the main issue in learning Newton's laws lies not merely in a lack of knowledge, but rather in the formation of incorrect and deviant conceptual understandings that differ from scientifically accepted physics concepts and tend to remain relatively stable despite formal instruction [27].

The misconception category accounted for a relatively substantial percentage, amounting to 21.39%. This result indicates that more than one-fifth of the students possessed incorrect conceptual understandings that they strongly believed to be correct. Misconceptions constitute a primary concern in this study because they are resistant to conventional instruction and tend to persist over time. The relatively high percentage of misconceptions suggests that the instruction on Newton's laws received by the students has not yet fully succeeded in fostering scientifically accurate and coherent conceptual understanding. This finding is consistent with previous studies reporting that concepts related to force and motion are among the most susceptible physics topics to persistent misconceptions that are difficult to remediate [28,29].

In addition to misconceptions, the negative error category also showed a considerable percentage of 16.82%. Negative errors represent a condition in which students select incorrect answers with high confidence despite providing correct reasoning. This situation indicates that students' understanding of Newton's laws is still unstable and remains in a transitional phase between intuitive reasoning and scientific reasoning. Unlike misconceptions, negative errors present greater potential for remediation through conceptual instruction that emphasizes the integrated relationships among physical quantities. When the misconception and negative error categories are combined, a total percentage of 38.21% is obtained, indicating that nearly two-fifths of students' understanding remains conceptually problematic.

The lack of understanding category accounted for 12.98%, indicating that some students had not yet developed a clear conceptual framework regarding Newton's laws, either in the form of correct understanding or systematic misconceptions. Students within this category tended to respond based on guessing or unstructured reasoning. Although this percentage is lower than those of the misconception and negative error categories, its presence nevertheless indicates that the instructional process has not yet fully reached all students. Meanwhile, the positive error category showed the lowest percentage, at 4.82%. Positive errors describe a condition in which students select correct answers with high confidence but provide incorrect reasoning, reflecting procedural understanding that is not yet accompanied by comprehensive conceptual understanding.

From the perspective of misconception patterns, the findings indicate that students' errors were not merely procedural mistakes or calculation errors, but were closely related to their conceptual understanding of the relationships among force, mass, acceleration, and an object's state of motion. Misconceptions were evident in students' tendencies to associate motion directly with the presence of force, equate velocity with acceleration, and relate the magnitude of force to an object's mass or size. These patterns demonstrate the strong influence of everyday experiences and intuitive reasoning in shaping students' understanding, in which the concept of net force and the causal relationships among physical quantities have not yet been conceptually internalized. This finding aligns with recent studies reporting that everyday intuition often conflicts with formal physics concepts and tends to persist even after students have received formal instruction in mechanics [30].

Overall, these global findings confirm that although the sound understanding category exhibited the highest percentage, students' understanding of Newton's laws cannot yet be considered optimal. The primary issue lies not only in insufficient understanding but also in the formation of alternative conceptions that are incorrect yet strongly believed. Therefore, to obtain a more in-depth picture of the characteristics of students' misconceptions, the subsequent discussion is organized according to each of Newton's laws, allowing misconception patterns in Newton's First Law, Second Law, and Third Law to be analyzed more specifically.

Students' misconception levels based on sub-concepts of Newton's laws were analyzed by recapitulating the percentages of students' conceptual understanding categories across test items representing each of Newton's laws. This approach provided a more comprehensive depiction of misconception levels within each sub-concept. The percentages of students' conceptual understanding categories for each sub-concept of Newton's laws are presented in Table 7.

Table 7. Percentages of students' conceptual understanding categories for each sub-concept of Newton's laws.

Subconcept	Conceptual Understanding Category				
	Misconception	Lack of Understanding	Sound Understanding	Positive Error	Negative Error
Newton's First Law	15.98%	13.64%	47.58%	5.23%	17.58%
Newton's Second Law	17.42%	12.20%	46.14%	4.17%	20.08%
Newton's Third Law	30.76%	13.11%	38.26%	5.08%	12.80%

Based on Table 7, misconceptions consistently emerged across all three sub-concepts of Newton's laws, although at varying levels. The percentage of misconceptions tended to increase from Newton's

First Law to Newton's Second Law and reached its highest level in Newton's Third Law. This pattern indicates that students' understanding of force and motion has not yet been constructed in a comprehensive and integrated manner, and that misconceptions formed in earlier laws may influence students' understanding of subsequent laws. This finding is consistent with the study by Mustofa et al. (2024), which reported that misconceptions related to fundamental concepts of force and net force are interrelated and mutually influential across Newton's laws [27].

Students' understanding of Newton's laws exhibits distinct misconception characteristics within each sub-concept, although these misconceptions are generally interconnected and hierarchical in nature. To facilitate clarity and provide a concise overview of the emerging misconception patterns, the dominant misconceptions and representative examples for each sub-concept are summarized in tabular form and subsequently discussed narratively. As an initial illustration, examples of students' responses indicating misconceptions in the sub-concept of Newton's First Law are presented below.

Table 8. Examples of students' responses indicating misconceptions in the sub-concept of Newton's first law.

Student	Response (translated from Indonesian)
Student 1	"The box will stop because there is no force pushing it."
Student 2	"It stops because there is no force pushing it."

In one test item concerning the motion of an object on a frictionless surface, several students stated that "the object will stop because there is no force pushing it anymore." These responses were accompanied by high confidence levels, indicating that students believed a force is required to maintain motion. This example illustrates that force was still understood as the cause of velocity rather than the cause of acceleration, suggesting that the concept of inertia had not yet been conceptually internalized. Similar misconception patterns were also observed in students' responses stating that "if the net force is zero, then the object must be at rest," indicating that uniform linear motion was not recognized as a condition consistent with Newton's First Law. These examples demonstrate the strong influence of intuition-based reasoning derived from everyday experiences in students' understanding of object motion. Based on the overall analysis of students' responses, a summary of the dominant misconception patterns and representative examples for the sub-concept of Newton's First Law is presented in Table 9.

Table 9. Dominant misconception patterns in the sub-concept of Newton's first law.

Misconception Pattern	Example of Misconception
Everyday-experience-based understanding	Objects are believed to require a force in order to continue moving
Equating zero net force with rest	Objects with zero net force are assumed to be unable to move
Inaccurate force modeling for stationary objects	Stationary objects are assumed to experience no forces
Misunderstanding of frictional force	Objects on frictionless surfaces are assumed to experience no forces and therefore cannot undergo changes in motion

Based on Table 9, it is evident that students still tend to interpret force as the cause of velocity rather than as the cause of acceleration. As a result, the concept of inertia has not been conceptually established, even under ideal conditions such as frictionless surfaces or vacuum environments. In addition, equating a zero net force condition with a state of rest indicates that students have not yet been able to distinguish between velocity and acceleration as two different physical quantities. This finding is consistent with previous studies reporting the strong influence of everyday experiences in shaping students' intuitive reasoning about motion [31]. Nevertheless, misconceptions related to Newton's First Law can be reduced through instructional approaches that explicitly emphasize force representations and real-world contexts [32].

The limitations in conceptual understanding of Newton's First Law persist and become more complex in Newton's Second Law, which concerns the relationship between force, mass, and acceleration. The dominant misconception patterns identified in this sub-concept are summarized in Table 10.

Table 10. Dominant misconception patterns in the sub-concept of Newton's second law.

Misconception Pattern	Example of Misconception
Everyday-motion-based intuition	Acceleration is understood as "fast motion" or simply "an object moving," rather than as a change in velocity due to a net force
Separation between acceleration and net force concepts	Students determine the presence or absence of acceleration based on the magnitude of velocity, not on the existence of a net force
Interpreting mass as the sole determinant of motion	Objects with greater mass are assumed to necessarily have greater or smaller acceleration without considering the applied force
Misinterpretation of Newton's Second Law in gravitational contexts	In free-fall motion, acceleration is believed to depend on the mass or material of the object
Motion analysis without force modeling	In horizontal or inclined motion, acceleration is linked to initial velocity or mass without identifying the forces involved and their resultant
Formula memorization dominance	Students can write the equation $a = F/m$ but are unable to explain the physical meaning of the relationship between the variables

Table 11. Dominant misconception patterns in the sub-concept of Newton's third law.

Misconception Pattern	Example of Misconception
Equating force magnitude with mass or object size	In a collision between a truck and a small car, the truck is assumed to exert a greater force because of its larger mass or the more severe damage caused
Reasoning based on motion outcome or damage	The magnitude of action–reaction forces is judged based on the degree of motion change or damage after the interaction
Force assumed to exist only when motion occurs	When pushing against a wall, students believe that no reaction force exists because there is no displacement
Confusion between force pairs and net force	Action and reaction forces are assumed to cancel each other out because they act in opposite directions
Misunderstanding of gravitational interaction	In the case of a falling apple, only the Earth is believed to exert a gravitational force on the apple, while the apple is not considered to exert a force on the Earth
Phenomenological understanding without interaction analysis	The motion of a released balloon is explained without relating the force pair between the balloon and the escaping air
Incorrect identification of Newton's laws	Inertial phenomena, such as passengers being thrown forward when a vehicle suddenly stops, are considered applications of Newton's Third Law
Reaction force viewed as a consequence	The reaction force is believed to arise after the action force occurs, rather than simultaneously

Table 10 shows that although students are familiar with the equation $\Sigma F = ma$, their understanding remains procedural and detached from the physical meaning of the relationships among the quantities involved. Acceleration is often interpreted as velocity, while force and mass are treated as independent factors. In vertical motion and inclined-plane contexts, students are unable to correctly identify the forces acting on an object and determine the net force. This condition indicates a weak conceptual linkage between Newton's First and Second Laws, as also reported in previous studies [33].

The most complex level of misconception was found in Newton's Third Law, which relates to the understanding of action–reaction forces as interactions between objects. A summary of the dominant misconception patterns identified in this sub-concept is presented in Table 11. Based on Table 11, it is evident that students have not yet understood the nature of action–reaction forces as force pairs that are always equal in magnitude, opposite in direction, and acting on two different objects. The magnitude of force is still frequently associated with the resulting motion or the degree of damage produced, and is often conflated with the concept of net force that determines motion. These difficulties indicate that the concept of force interaction in Newton's Third Law is more abstract and requires a higher level of conceptual representation than the previous two laws, as also reported in previous studies [34].

Overall, misconceptions related to Newton's First, Second, and Third Laws exhibit interconnected patterns rooted in the dominance of intuitive reasoning and weak understanding of systematic force analysis. Students tend to memorize the statements of the laws and their mathematical formulas without comprehending the underlying physical meaning. These findings emphasize that instruction on Newton's Laws needs to be designed in a more conceptual and integrated manner, with particular emphasis on force modeling, analysis of interactions between objects, and clear differentiation among the three Newton's Laws across various physical contexts in order to minimize persistent misconceptions. The consistency of these misconception patterns indicates that conceptual errors do not arise randomly, but are formed through specific sources that influence how students construct their initial understanding of Newton's Laws.

The sources of students' misconceptions regarding Newton's Laws were identified based on the information provided by students concerning the references they used when answering the diagnostic test items. The analysis of misconception sources was conducted globally by considering all test items related to Newton's Laws, thereby obtaining a general overview of the origins of students' misconceptions. The percentage distribution of misconception sources is presented in Table 12.

Table 12. Distribution of students' misconception sources on Newton's laws.

Source of Misconception	Percentage	Description
Self-generated reasoning	78.86%	High
Textbooks	6.97%	Low
Teachers	7.79%	Low
Peers	6.14%	Low
Others	0.24%	Low

The results of the analysis indicate that the most dominant source of students' misconceptions originates from their own reasoning. This finding suggests that most students construct their understanding of Newton's Laws based on intuition, everyday experiences, and personal reasoning that do not always align with scientific physics concepts. Such intuitive reasoning tends to be relatively stable and resistant to change, thereby increasing the likelihood of forming persistent misconceptions even after students have received formal instruction. This result is consistent with previous studies reporting that physics misconceptions are generally formed prior to formal learning and arise from students' initial knowledge constructions [35,36].

The dominance of self-generated sources of misconceptions indicates that students frequently rely on intuitive reasoning when explaining physical phenomena, such as associating force with visible motion, mass with an object's "strength," or motion effects with the magnitude of force. These reasoning patterns produce internally consistent explanations that are conceptually incorrect. Recent studies have also reported that the use of everyday intuition in interpreting Newton's Laws is one of the main factors contributing to the persistence of misconceptions [37,38].

In addition to self-generated reasoning, students' misconceptions also originate from teachers, textbooks, and peers, although in relatively smaller proportions. This finding indicates that misconceptions are not formed solely at the individual level but may also be influenced by instructional practices, the use of inappropriate examples or analogies, and interactions among students during the learning process. Although their contributions are not dominant, sources of misconceptions stemming from teachers and textbooks still require serious attention, as these are primary references in physics learning. This result is in line with previous research suggesting that social interactions and the way concepts are presented during instruction can reinforce students' pre-existing misconceptions [39,40].

Sources of misconceptions dominated by internet-based references were found in relatively small proportions. This finding indicates that students' use of online resources in understanding Newton's Laws remains limited or has not yet become a primary reference compared to other learning sources. Nevertheless, the potential of the internet as a source of misconceptions should not be overlooked, given students' increasing access to digital information.

Overall, the results of this study confirm that students' misconceptions regarding Newton's Laws predominantly stem from their internal knowledge constructions rather than solely from errors in external learning resources. Therefore, physics instruction needs to be designed to explicitly elicit, examine, and reconstruct students' initial conceptions. The use of diagnostic instruments, the creation of cognitive conflict, conceptually driven discussions, and emphasis on causal relationships among physical quantities are essential strategies for effectively reducing established misconceptions.

4. Conclusion

Based on the results of this study, students' conceptual understanding of Newton's Laws is still not optimal. Although the category of conceptual understanding shows the highest percentage (43.99%), more than half of the students fall into problematic categories, particularly misconceptions and negative errors. Misconceptions were identified across all three sub-concepts of Newton's Laws, with the highest level found in Newton's Third Law, especially in understanding action–reaction force pairs. These misconceptions indicate that many students tend to rely on memorization of formulas and verbal statements of the laws without fully understanding their underlying physical meanings. In addition, the findings reveal that students' misconceptions are predominantly influenced by internal cognitive constructions derived from intuition and everyday experiences, which tend to be stable and resistant to formal instruction. Therefore, physics instruction on Newton's Laws should emphasize conceptual understanding through strategies that elicit and reconstruct students' initial conceptions, such as conceptual discussions, force analysis, and the use of diagnostic assessments to identify and address persistent misconceptions. However, since the identification of misconception sources in this study is based on students' self-reported responses, further research is recommended to employ in-depth interviews or qualitative approaches to more accurately explore the origins of students' misconceptions.

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References

[1] Rahmina A, Wahyuni A, Zainuddin, Hamid A and Musdar 2024 The Improvement of Students' Conceptual Understanding Using the Experimental Learning Method *Asian Journal of Science Education* **6** 32–41
[2] Suhartin Y, Prastowo S H B and Prihandono T 2017 Analisis Pemahaman Konsep Spektrum Cahaya pada Siswa SMA Kelas XII *Seminar Nasional Pendidikan Fisika 2017* vol 2 pp 1–6
[3] Kotsis K T 2026 Persistent Misconceptions in Physics Education Across Educational Levels : Patterns , Instructional Responses , and Future Directions *European Journal of Contemporary Education and E-Learning* **4** 185–97

[4] Adimayuda R, Suhandi A, Samsudin A, Suhendi E, Setiawan A, Fratiwi N J and Kapici H O 2026 A Review of College Student in Physics Education : Type , Cause and Remediation Misconception *Journal of Innovation in Educational and Cultural Research* **7** 143–52
[5] Izza R I, Nurhamidah N and Elvinawati E 2021 Analisis Miskonsepsi Siswa Menggunakan Tes Diagnostik Esai Berbantuan Cri (Certainty of Response Index) Pada Pokok Bahasan Asam Basa *Alotrop* **5** 55–63
[6] Malikha Z and Amir M F 2018 Analisis Miskonsepsi Siswa Kelas V-B Min Buduran Sidoarjo Pada Materi Pecahan Ditinjau Dari Kemampuan Matematika *Pi: Mathematics Education Journal* **1** 75–81
[7] Wulandari S, Gusmalini A and Zulfarina Z 2021 Analisis Miskonsepsi Mahasiswa Pada Konsep Genetika Menggunakan Instrumen Four Tier Diagnostic Test *Jurnal Pendidikan Sains Indonesia* **9** 642–54
[8] Sudiatmika A A I A R and Subagia I wayan 2022 Profil Miskonsepsi Mahasiswa Prodi S2 Pendidikan IPA pada Materi Optik menggunakan Tes Diagnostik Four Tier Test *Wahana Matematika dan Sains: Jurnal Matematika, Sains, dan Pembelajarannya* **16** 45–52
[9] Murdani E 2020 Hakikat Fisika dan Keterampilan Proses Sains *Jurnal Filsafat Indonesia* **3** 72–80
[10] Alatas F, Ilhamiah S and Suryadi A 2021 Identification of Students' Misconceptions Using Isomorphic Test: the Case of Newton'S Law of Motion *Edusains* **13** 174–84
[11] Betari A, Hasanati A, Fuadah F, Amir M T and Parno P 2021 Students' Learning Motivation through the Quality of Scientific Argumentation Skills and Students' Cognitive Learning Outcomes on Newton's Laws: A Relationship Analysis *Jurnal Ilmiah Pendidikan Fisika Al-Biruni* **10** 71–84
[12] Parra Zeltzer V, Huincahue Arcos J and Abril Milan D 2024 What does Newton's second law say? A comparison between Principia and university and school physics texts in Chile *Proceedings of World Multi-Conference on Systemics, Cybernetics and Informatics, WMSCI* 256–62
[13] Mutia S, Muliani, Ayunda D S, Ginting F W and Absa M 2025 Penerapan Model Guided Discovery Learning (GDL) Untuk Mereduksi Miskonsepsi Siswa Pada Materi Hukum Newton *RELATIVITAS: Jurnal Riset Inovasi Pembelajaran Fisika* **8** 1–7
[14] Rizkita N I and Mufit F 2022 Analisis Pemahaman Konsep dan Sikap Siswa Terhadap Belajar Fisika Pada Materi Hukum Newton Tentang Gerak *Jurnal Eksakta Pendidikan (JEP)* **6** 233–42
[15] Polverini G and Gregorcic B 2024 How understanding large language models can inform the use of ChatGPT in physics education *European Journal of Physics* **45** 1–35
[16] Rosenblatt R and Heckler A F 2011 Systematic study of student understanding of the relationships between the directions of force, velocity, and acceleration in one dimension *Physical Review Special Topics - Physics Education Research* **7** 1–20
[17] Atsilah M B, Suhadi S, Putri J K, Mabruroh F, Sugiarti S and Pebralia J 2024 Pengembangan Three Tier Test Multiple Choice Untuk Mengidentifikasi Miskonsepsi Pada Materi Hukum Newton *Jurnal Penelitian Pembelajaran Fisika* **15** 213–21
[18] Sari A L R, Parno and Taufiq A 2018 Pemahaman Konsep dan Kesulitan Siswa SMA pada Materi Hukum Newton *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan* **3** 1323–30
[19] Setyabudi L D and Rosdiana L 2020 Identifikasi Miskonsepsi Materi Hukum Newton Menggunakan Certainty of Response Index (CRI) pada Siswa Kelas VIII SMP *Pensa E-Jurnal: Pendidikan Sains* **8** 340–5
[20] Silaban B, Surbakti M B, Silaban I J A and Purba J 2024 Identifikasi Miskonsepsi Peserta Didik SMA Melalui Tes Diagnostik Four-Tier pada Hukum Newton *Lensa: Jurnal Kependidikan Fisika* **12** 260–74
[21] Sitepu E B and Yakob M 2019 Analisis Miskonsepsi Siswa pada Materi Hukum Newton di Kelas X IPA SMA Negeri 1 Berastagi *GRAVITASI Jurnal Pendidikan Fisika dan Sains* **2** 23–9
[22] Azzahidah M 'Abidah, Kusairi S, Hanatan A and Hariyanto H 2024 Analisis Kesulitan Siswa SMA Pada Materi Hukum Newton Menggunakan Instrumen Force Concept Inventory (FCI) *Jurnal Penelitian Pembelajaran Fisika* **15** 7–17
[23] Smith T I and Wittmann M C 2007 Comparing three methods for teaching Newton's third law *Physical Review Special Topics - Physics Education Research* **3** 1–8

[24] Utami I, Mulyani B and Yamtinah S 2020 Identifikasi Miskonsepsi Asam-Basa dengan Two Tier Multiple Choice dilengkapi Interview *Jurnal Pendidikan Kimia* **9** 89–97

[25] Dhona L R 2024 *Lawdy Rahma Dhona_201101080015* (UIN Kiai Haji Achmad Siddiq Jember)

[26] Zulfa F N, Ngazizah N and Pangestika R R 2025 Analisis Miskonsepsi IPA Materi Fotosintesis Ditinjau dari Perspektif Siswa *Cetta: Jurnal Ilmu Pendidikan* **8** 211–26

[27] Mustofa, Zain, Tsania, Azman, Marmoah and Masfuah 2024 Analysis Of Students' Conceptions Based On Cognitive Style On Newton's Law Understanding *Jurnal Pendidikan IPA Indonesia* **13** 301–12

[28] Suban M E, Hidayatullah Z and Nurhasanah 2024 Identifikasi Miskonsepsi Menggunakan Three-Tier Diagnostic Test dan Representasi Gambar pada Konsep Gaya *Hamzanwadi Journal of Science Education* **1** 1–9

[29] Mukminin A, Mukhlisa N and Muslimin 2025 Faktor-Faktor Penyebab Miskonsepsi Peserta Didik Pada Materi Sains Sekolah Dasar di Kota Parepare *DIKDAS MATAPPA: Jurnal Ilmu Pendidikan Dasar* **8** 218–25

[30] Wahyudi, Syahrial A and Zuhdi M 2025 Menyingkap Miskonsepsi Gaya dan Gerak : Studi Kasus pada Mahasiswa Pendidikan Fisika FKIP Universitas Mataram dan Rekomendasi Perbaikan *Jurnal Pendidikan, Sains, Geologi, dan Geofisika* **6** 2433–8

[31] Ablanque J, Revuelta F, Losada J C and Benito R M 2024 Persistence of Conceptual Errors in First-Year University Physics Course and Its Possible Relationship with Learning Styles *Education Sciences* **14** 1–23

[32] Sinaga H, Yakob M and Nafaida R 2019 Remediasi Miskonsepsi Konsep Hukum Newton dengan Menggunakan Metode Eksperimen di Kelas X SMA Negeri 3 Langsa *GRAVITASI Jurnal Pendidikan Fisika dan Sains* **2** 30–3

[33] Taqwa M R A, Shodiqin M I and Zainuddin A 2020 Kesulitan Mahasiswa Dalam Memahami Konsep Gaya Dan Gerak *LENSA (Lentera Sains): Jurnal Pendidikan IPA* **10** 25–39

[34] Wicaksiwi A K and Mayangsari F D 2022 Pengembangan Prototipe Media Pembelajaran pada Alat Peraga "Mobil Bertenaga Angin" *Jurnal Penelitian Pendidikan Matematika dan Sains (JPPMS)* **6** 25–31

[35] Mustari M, Anggereni S, Sodikin, Fitria and Yusandika A D 2020 Identification of students' misconceptions using the Certainty of Response Index (CRI) from work and energy material *Journal of Physics: Conference Series* 1–10

[36] Purwaningtias W S and Putra N M D 2020 Analisis Tingkat Pemahaman Konsep dan Miskonsepsi Fisika pada Pokok Bahasan Alat-alat Optik di SMA Negeri 1 Purwodadi *Unnes Physics Education Journal (UPEJ)* **9** 139–48

[37] Mushthofa Z, Rusilowati A, Marwoto P and Mindyarto B N 2020 Misconception Profile of Newton's Law Concept Using Certainty of Response Index (CRI) *Physics Communication* **4** 5–12

[38] Budiman J Y, Samsudin A and Aminudin A 2025 Investigating students ' conceptual change in learning newton ' s laws through a project-based learning design informed by understanding by design *Journal of Advanced Sciences and Mathematics Education* **5** 541–53

[39] Soeharto, Csapó B, Sarimanah E, Dewi F I and Sabri T 2019 Jurnal Pendidikan IPA Indonesia A Review Of Students' Common Misconceptions In Science And Their Diagnostic Assessment Tools *Jurnal Pendidikan IPA Indonesia* **8** 247–66

[40] Putri O W, Yani A and Fitriawan D 2025 Eksplorasi Miskonsepsi Siswa Berdasarkan Gaya Belajar Visual, Auditori, Kinestetik (Vak) Pada Materi Bangun Datar Segiempat *Journal Of Educational Review And Research (JERR)* **8** 42–9