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Exploring Students' Conceptual Understanding of Newton's Law in Senior High School

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Abstract

This study aims to explore high school students' understanding of Newton's laws of motion. The research method used is qualitative descriptive, with data collection through a two-tier diagnostic test. The instrument not only measures correct answers but also explores the reasons behind students' choices. Data analysis was conducted by dividing students' understanding into four categories: (1) Understanding the concept; (2) Misconception; (3) Not understanding the concept; and (4) Guessing. The results showed that students understood the concept of changes in velocity due to changes in the direction of force, with 56.2% of students understanding the concept. The largest misconception was found in the subtopic of Newton's Third Law, which reached 68.5%. Meanwhile, the percentage of students who did not understand the concept was lower than that of students who had misconceptions in all subtopics. These findings confirm that the majority of students did not understand the concept, but had initial understandings that were unscientific or inappropriate. Therefore, teachers need to prepare learning strategies that are not only informative but also reinforce concepts.

Keywords: Conceptual Understanding; Misconception; Newton's Law

INTRODUCTION

Physics education aims to build important skills that are the main focus in science education (Nasir et al., 2025). The foundation of various important skills is a deep understanding of concepts. A solid understanding of concepts is considered a key element for students to master procedural and sequential learning topics (Bao & Fritchman, 2021; Xie et al., 2021). However, before embedding conceptual understanding, it is important to first understand the needs of students (Prima et al., 2024).

Newton's laws are a fundamental aspect of physics education because they form the basis for understanding the principles of motion, force, and interaction between objects. Newton's laws allow humans to explain and predict natural phenomena and technology in various fields. The importance of Newton's laws is in their role in the development of technology, engineering, and biomechanics (Li, 2025; Subak, 2025). In addition, mastery of this topic is very important because it is the basis for other physics topics (Suganda et al., 2021). Some high school physics topics related to Newton's laws include work and energy, momentum and impulse, and electricity.

The main challenge in building conceptual understanding is the high rate of misconceptions. Misconceptions are not only found in Newton's Laws, but also in other physics topics, such as parabolic motion (Hidayat & Mufit, 2024). Students often come to class with

prior understandings based on intuition. These prior understandings can conflict with scientific concepts. Before formulating a solution, the first step that needs to be taken is to conduct an initial identification with the help of diagnostic tests (Patricia & Sabani, 2025).

Early identification or diagnosis of students' understanding of Newton's Law concepts is very important because the high level of misconceptions experienced by students can hinder the learning process. Through diagnostic instruments such as three-tier or four-tier tests, teachers can identify the location and type of misconceptions experienced by students on the topic of Newton's Laws (Rahmawati et al., 2020; Rusilowati et al., 2021). This identification helps teachers determine appropriate learning for students, so that misconceptions can be minimized and students' conceptual understanding can be improved. This study aims to analyze students' conceptual understanding of Newton's Laws in schools that have not been tested.

METHOD

This study aims to explore high school students' conceptual understanding of Newton's Laws. The research method used in this study is quantitative descriptive. Data collection techniques were conducted using tests. The instrument used to collect data was a two-tier diagnostic test in the form of multiple-choice questions with explanations. Quantitative data were obtained from students' concept comprehension scores, while qualitative data were obtained from students' misconceptions about Newton's laws. The subjects of this study were 73 high school 11th-grade students. Data analysis was performed using descriptive statistics to reveal the profile of students' concept understanding and identify the percentage of students who had misconceptions. Students' conceptual understanding categories were grouped based on Table 1.

Table 1. Students' Conceptual Understanding Category

Category	Description
Understanding	Correct answers and correct reasons
Misconception	Incorrect answers, but supported by coherent reasons
Not understanding	Incorrect answers and incorrect or irrelevant reasons
Guessing	Correct answers, but incorrect or irrelevant reasons

RESULTS AND DISCUSSION

This study identified students' conceptual understanding of Newton's laws through a two-tier diagnostic test. This approach aimed not only to measure correct or incorrect answers, but also to explore the reasoning behind them. Students' understanding was grouped into four categories according to the subtopics in Newton's laws. The percentage of students' conceptual understanding of each subtopic can be seen in Table 2.

Table 2. Percentage of Student Conceptual Understanding

No.	Subtopic	Percentage			
		Understanding	Misconception	Not Understanding	Guessing
1.	Newton's first law	38.4%	34.2%	11.0%	16.4%
2.	Newton's second law	30.1%	41.1%	12.3%	16.4%
3.	Newton's third law	12.3%	68.5%	12.3%	6.8%
4.	Gravitational acceleration at the peak	27.4%	53.4%	11.0%	8.2%
5.	Change in velocity due to opposing forces	56.2%	13.7%	13.7%	16.4%

Based on Table 2, it is known that there are critical findings in Newton's Third Law regarding action and reaction. As many as 68.5% of students were identified as having misconceptions. This is the highest percentage of misconceptions of all subtopics in Newton's Law. This shows that the majority of students still believe in the wrong concept. The majority of students think that stationary objects do not exert a reaction. A quite high misconception was also found in the subtopic of gravitational acceleration at the peak, at 53.4%. In this subtopic, some students could not distinguish between gravitational acceleration and the velocity of objects at the peak.

The problems observed in Newton's Third Law were also found in previous studies. The high percentage of misconceptions is in line with the study by Sundaygara et al. (2021), which states that misconceptions about the concepts of action-reaction and force often occur. This could be caused by students' initial misconceptions or daily experiences that are not in line with scientific concepts. Students tend to believe that stationary objects do not exert a reaction or that the force of action is always greater than the reaction (Isra & Mufit, 2023; Rusilowati et al., 2021), even though in physics, the two forces are equal in magnitude and opposite in direction.

The second-highest misconception was found in the subtopic on gravitational acceleration at the peak of height. In this subtopic, students focused on the fact that objects stop momentarily at the peak, leading them to mistakenly conclude that if the velocity is zero, then the acceleration is also zero. In previous studies, many students believed that when an object stops momentarily at its peak, the acceleration will also be zero (Defianti & Rohmi, 2021; Piten et al., 2017; Yulianti et al., 2020). Phenomenon-based learning and simulation can reduce misconceptions caused by students' difficulties in visualizing this concept.

In the subtopic of Newton's First Law, the majority of students believe that the initial force provides residual force or residual energy that keeps the object moving. The study by Wancham et al. (2023) explains the cause of this misconception as being due to students

assuming that force remains constant while an object is in motion. Students imagine that force remains after the initial force is applied, whereas according to Newton's First Law, an object will continue to move in a straight line without the need for additional force if no external force is applied (Isra & Mufit, 2023).

Students experience other misconceptions in the subtopics of Newton's Second Law and changes in velocity due to opposing forces. Students think that opposing forces will immediately reverse the direction of the object or stop it without a deceleration process. This misconception shows an inaccurate understanding of the relationship between force and acceleration according to Newton's Second Law (Parra-Zeltzer et al., 2025; Samsudin et al., 2021). Students generalize their everyday experiences by assuming that opposing forces work instantly and ignore the gradual process of changing velocity (Kurniawan, 2018).

There are more students in the misconception category than in the concept misunderstanding category. In almost all questions, the percentage of students who misunderstand the concept is only around 11%. This figure is lower than the misconception rate, which can reach 68.5%. This indicates that students do not lack knowledge altogether, but rather have alternative knowledge that tends to be unscientific or incorrect. Some understandings that indicate student misconceptions include the belief that *force will be exhausted or that the action force is greater than the reaction force because the object is stationary*.

The number of students with misconceptions was higher than those who did not understand the concept or guessed the answer. These misconceptions can arise because students build knowledge based on daily experiences, intuition, or inaccurate explanations from teachers, resulting in incorrect knowledge (Sundaygara et al., 2021). This dominance indicates the need for learning strategies that target the correction of alternative knowledge, not just the giving of new information. In addition, this also requires teachers not only to teach concepts, but also to actively identify and reconstruct students' conceptions (Chen et al., 2020; Kamilah et al., 2025).

CONCLUSION

This study aims to explore high school students' Conceptual Understanding of Newton's Laws. The results indicate that misconceptions remain a major issue in Newton's Laws, particularly in Newton's Third Law of Motion. These misconceptions are generally caused by incorrect initial knowledge, daily experiences, or inappropriate teaching methods. Therefore, teachers need to actively identify students' misconceptions through diagnostics and reconstruct

students' scientific understanding. Effective and engaging learning strategies need to be implemented to reduce students' misconceptions.

REFERENCES

Bao, L., & Fritchman, J. C. (2021). Knowledge integration in student learning of Newton's third law: Addressing the action-reaction language and the implied causality. *Physical Review Physics Education Research*, *17*(2), 1–22. https://doi.org/10.1103/PhysRevPhysEducRes.17.020116

Chen, C., Sonnert, G., Sadler, P. M., & Sunbury, S. (2020). The impact of high school life science teachers' subject matter knowledge and knowledge of student misconceptions on students' learning. *CBE Life Sciences Education*, *19*(1), 1–166. https://doi.org/10.1187/cbe.19-08-0164

Defianti, A., & Rohmi, P. (2021). Undergraduate student's misconception about projectile motion after learning physics during the Covid-19 pandemic era. *Journal of Physics: Conference Series*, *2098*(012026), 1–6. https://doi.org/10.1088/1742-6596/2098/1/012026

Hidayat, R., & Mufit, F. (2024). Analysis of Student Misconceptions and Their Causes on Parabolic Motion Using a Six-Tier Multiple Choice. *Physics Learning and Education*, *2*(3), 153–162. https://doi.org/10.24036/ple.v2i3.92

Isra, R. A., & Mufit, F. (2023). Students' conceptual understanding and causes of misconceptions on Newton's Law. *International Journal of Evaluation and Research in Education*, *12*(4), 1914–1924. https://doi.org/10.11591/ijere.v12i4.25568

Kamilah, D. S., Muki, B. G., Aviyanti, L., & Suhandi, A. (2025). Review of misconceptions in physics among Indonesian high school students: Diagnosis, causes, and remediation. *Momentum: Physics Education Journal*, *9*(2), 251–263. https://doi.org/10.21067/mpej.v9i2.11187

Kurniawan, Y. (2018). Investigation of the Misconception in Newton Ii Law. *Jurnal Pena Sains*, *5*(1), 11. https://doi.org/10.21107/jps.v5i1.3879

Li, Z. (2025). The Significance of Classical Mechanics in the Evolution of Space Exploration. *Theoretical and Natural Science*, *92*(1), 194–198. https://doi.org/10.54254/2753-8818/2025.22291

Nasir, M. H., Widiatmono, R., & Kuswanto, H. (2025). Problem Solving Skill in Physics Learning: Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 34–40. https://doi.org/10.29303/jppipa.v11i4.9579

Parra-Zeltzer, V. R., Huincahue, J., & Abril, D. (2025). Newton's Second Law Teaching Strategies—Identifying Opportunities for Educational Innovation. *Education Sciences*, *15*(6), 1–25. https://doi.org/10.3390/educsci15060748

Patricia, A., & Sabani. (2025). Analisis Miskonsepsi Siswa SMA pada Hukum Newton Menggunakan Four-Tier Test Berbasis CRI. *RELATIVITAS: Jurnal Riset Inovasi Pembelajaran Fisika*, *8*(2), 160–168.

Piten, S., Rakkapao, S., & Prasitpong, S. (2017). Cambodian students' prior knowledge of projectile motion. *Journal of Physics: Conference Series*, *901*(012116), 8–13. https://doi.org/10.1088/1742-6596/901/1/012116

Prima, W. A. P., Khusaini, & Hidayat, A. (2024). Students needs investigation on learning newton's law of physics: explanatory sequential. *Jurnal Riset Dan Kajian Pendidikan Fisika*, *11*(2), 49–60. https://doi.org/10.12928/jrkpf.v11i2.718

Rahmawati, D. U., Jumadi, Kuswanto, H., & Oktaba, I. A. (2020). Identification of students' misconception with isomorphic multiple choices test on the force and newton's law material. *Journal of Physics: Conference Series*, *1440*(1). https://doi.org/10.1088/1742-6596/1440/1/012052

Rusilowati, A., Susanti, R., Sulistyaningsing, T., Asih, T. S. N., Fiona, E., & Aryani, A. (2021). Identify misconception with multiple choice three tier diagnostik test on newton law material. *Journal of Physics: Conference Series*, *1918*(5). https://doi.org/10.1088/1742-6596/1918/5/052058

Samsudin, A., Afif, N. F., Nugraha, M. G., Suhandi, A., Fratiwi, N. J., Aminudin, A. H., Adimayuda, R., Linuwih, S., & Costu, B. (2021). Reconstructing Students' Misconceptions on Work and Energy through the PDEODE*E Tasks with Think-Pair-Share. *Journal of Turkish Science Education*, *18*(1), 118–144. https://doi.org/10.36681/tused.2021.56

Subak, G. E. (2025). Newton's Second Law in Sports Science and Biomechanics: Bridging Physics and Human Performance. *American Journal of Sports Science*, *13*(2), 32–38. https://doi.org/10.11648/j.ajss.20251302.12

Suganda, T., Purwaningsih, E., & Parno, P. (2021). The problem of physics learning: The effort to increase the interest and learning result of Newton laws. *Berkala Fisika Indonesia : Jurnal Ilmiah Fisika, Pembelajaran Dan Aplikasinya*, *12*(1), 25–32. https://doi.org/10.12928/bfi-jifpa.v12i1.20334

Sundaygara, C., Gusi, L. A. R. P., Pratiwi, H. Y., Ayu, H. D., Jufriadi, A., & Hudha, M. N. (2021). Identification students' misconception using four-tier diagnostic test on Newton Law subject. *Journal of Physics: Conference Series*, *1869*(012157), 1–5. https://doi.org/10.1088/1742-6596/1869/1/012157

Wancham, K., Tangdhanakanond, K., & Kanjanawasee, S. (2023). Sex and Grade Issues in Influencing Misconceptions about Force and Laws of Motion: An Application of Cognitively Diagnostic Assessment. *International Journal of Instruction*, *16*(2), 437–456. https://doi.org/10.29333/iji.2023.16224a

Xie, L., Liu, Q., Lu, H., Wang, Q., Han, J., Feng, X. M., & Bao, L. (2021). Student knowledge integration in learning mechanical wave propagation. *Physical Review Physics Education Research*, *17*(2), 20122. https://doi.org/10.1103/PhysRevPhysEducRes.17.020122

Yulianti, E., Mustikasari, V. R., Hamimi, E., Rahman, N. F. A., & Nurjanah, L. F. (2020). Experimental evidence of enhancing scientific reasoning through guided inquiry model approach. *AIP Conference Proceedings*, *2215*(April). https://doi.org/10.1063/5.0000637