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What are the Misconceptions that occur to Students in Science Learning in Indonesia? A Systematic Literature Review

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Abstract: This study is a systematic review of 26 articles published between 2017 and 2024, focusing on misconceptions in science education within Indonesian schools. Misconceptions, defined as persistent misunderstandings that hinder effective learning, are a significant barrier to students' scientific literacy. The research employs the Systematic Literature Review (SLR) method, following the PRISMA model, to synthesize findings and address key research questions regarding these misconceptions.The analysis reveals that the majority of misconceptions were identified in 2023, accounting for 27% of the total findings, with a notable prevalence at the high school level (50%), followed by junior high (31%) and elementary schools (19%). In terms of subjects, physics misconceptions dominate at 50%, followed by chemistry (31%) and biology (19%). Geographically, East Java emerges as a hotspot for these misconceptions, representing 27% of the cases analyzed.This research contributes to the field of science education by highlighting critical areas where misconceptions occur, particularly in physics at the high school level. By identifying these misconceptions, educators can develop targeted interventions to enhance teaching strategies and improve overall student comprehension in science, ultimately fostering better scientific literacy among Indonesian students.

Keywords: Systematic Literature Review, Misconception, Learning, Natural Sciences

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1. Introduction

Learning is an event intended to initiate, encourage, and support student learning activities (Gasong, 2023; Banarase and S Shirbahadurkar 2024; Gittings, Taplin, and R Kerr 2020; Kawuri, Ishafit, and Fayanto 2019; Zou et al. 2022). Learning, on the other hand, is the process that a person undergoes to acquire knowledge, which results in a change in the level of better practice (Hardiyanti et al., 2020; Octavia, S. A., 2020; S Vosniadou 2020).

Natural Science learning is an important part of school curricula around the world and shapes our understanding of the universe (Castañeda-Miranda et al. 2023; Hillmayr, Ziernwald, and Reinhold 2020; Puspita et al. 2024). However, interesting discussions often occur during the learning process about the difficulties students face in conveying scientific concepts (Dewi, S. & Ibrahim, T., 2019; Segara, Kartini, and V Setyaningrum 2024). Misconceptions, which can hinder a proper and in-depth understanding of the material being taught, are one of the biggest problems (Marzuki and M Diknasari 2020; Mukhlisa, N. 2021).

According to (N Suprapto 2020) misconceptions in science learning are complex phenomena and have many phases. Misconceptions not only affect students individually, but also hinder teachers from achieving learning goals. Misconceptions can lead to shallow understanding, difficulty applying scientific concepts, and even rejection of science itself if not addressed appropriately (García-Fernández, Sobrino-Costoso, and Ruiz-Gallardo 2022; Malaterre, Javaux, and P López-García 2023). Misconceptions in science learning can be caused by a number of different factors. One of them is the way students understand the world around them (Mukhlisa, N. 2021). Since childhood, students often learn about nature through hands-on experience, observation, and interaction with their world (Ruiz-Gallardo and Reavey 2019). However, this intuitive understanding does not always correspond to the scientific concepts taught in schools (Sedrakyan et al. 2020; Soeharto and Heliyon 2021).

According to (Afni et al. 2024) the way information is provided to students also causes misconceptions. When teachers or textbooks use ambiguous or unclear language, students can misunderstand concepts. In addition, psychological elements can contribute to the formation of misconceptions (Anderson and Gagliardi 2021; Malaterre et al., 2023). Therefore, even if students are given evidence that supports correct scientific ideas, they may ignore them or misinterpret them because they do not match their previous beliefs (Hidayat, F. et al. 2020).

To address this issue, educators must know about common sources of misconceptions and how to address them (NN Mubarok 2023). Teachers must find misconceptions of students. This can be achieved through a variety of means, such as class discussions, formative tests, or even direct observation of students' comprehension (Nisa' et al. 2022). To help students overcome misunderstandings, teachers can use a variety of approaches (Ginting, Prastowo, and Yusuf 2022). Presenting information in contrast involves comparing wrong ideas with correct ideas (Darwis, R., & Hardiansyah, 2022). Additionally, it is important for students to

be given the opportunity to reflect on what they know and correct what they misunderstood (Wulandari et al., 2023; S Vosniadou 2020). This can be achieved through reflection activities, such as reflection journals or group discussions, where students are asked to reflect on what they know about a particular scientific concept and correct their mistakes (Fasya, Sjaifuddin, and Kurniasih 2023).

These approaches can help teachers overcome misconceptions in science learning and help students understand natural sciences better. One way to solve problems is to find misconceptions in learning (NI Syar and Al Ibtida 2022). Although various approaches have been identified to assist teachers in discovering and addressing students' misconceptions, there are still ways that research needs to be addressed (Rafika and Syuhendri 2021). Many previous studies have focused more on generalized teaching methods without considering the specific context in Indonesia, such as cultural differences and the existing education system (Lu et al. 2021). This study aims to fill the gap by analyzing how the local context affects the emergence of misconceptions and the effectiveness of the approaches used by teachers.

While many methods have been proposed to address misconceptions, the lack of research measuring the long-term impact of such approaches on students' conceptual understanding is a concern (Sibomana, Karegeya, and Sentongo 2020). This research will explore not only the effectiveness of existing methods, but also how they can be adapted to improve students' understanding in the long run. It will also highlight the importance of collaboration between teachers and students in the learning process. Although reflection and group discussion have been identified as effective tools (Alam 2022), This research will delve deeper into how these interactions can be optimized to create a learning environment that is more inclusive and responsive to students' needs (Hamzah, Maat, and Ikhsan 2021). Thus, this research not only aims to identify and analyze existing misconceptions, but also to provide more contextual and sustainable recommendations in addressing these issues in science education in Indonesia. This research is expected to contribute significantly to the development of more effective and locally relevant teaching strategies. Based on the above information, this study analyzes misconceptions that occur in school learning in Indonesia using the systematic review method.

2. Method

This research is an in-depth literature review. Researchers discovered, studied, evaluated, and interpreted all available studies to apply the Systematic Literature Review (SLR) and the Preferred Reporting Items for Systematic Reviews and Metaanalyses model, also known as PRISMA. This method allows researchers to systematically review and identify journals by following established procedures. The systematic literature review method allows for the latest discoveries on research topics by encouraging evidence-based activities, allowing for more objective assessments of previous research, and finding new avenues for research (Booth et

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al. 2021; van Dinter, Tekinerdogan, and Catal 2021). To ensure systematic SLR, this study follows PRISMA guidelines.

Table 1. Source of Analysis Article

Publisher
https://www.sciencedirect.com
https://eric.ed.gov/
https://www.sinta.kemendikbud.go.id

Electronic scientific databases sought to identify relevant studies include ScienceDirect (Elsevier/Scopus), Eric and Sinta. The selection of these databases is based on their multidisciplinary scope, accessibility, and relevance to the theme. The search for electronic scientific database literature was carried out using the PRISMA framework. The data used in this study is secondary data. Secondary data applies the documentation method from existing data, not data obtained from direct observation. The procedure is divided into four stages: (1) identification, (2) screening, (3) feasibility, and (4) inclusion, as shown in figure 1 the first stage involves conducting a systematic search of electronic databases. Research is selected if it meets the following inclusion criteria: (a) this study seeks research to identify problems in the form of misconceptions that occur in students. (b) this research at the level of elementary and high school education occurred only in Indonesia. (c) This study was published in the 2017-2024 time frame. (d) research in the subjects of science, chemistry, physics, biology. The following is a graph chart of PRISMA criteria.

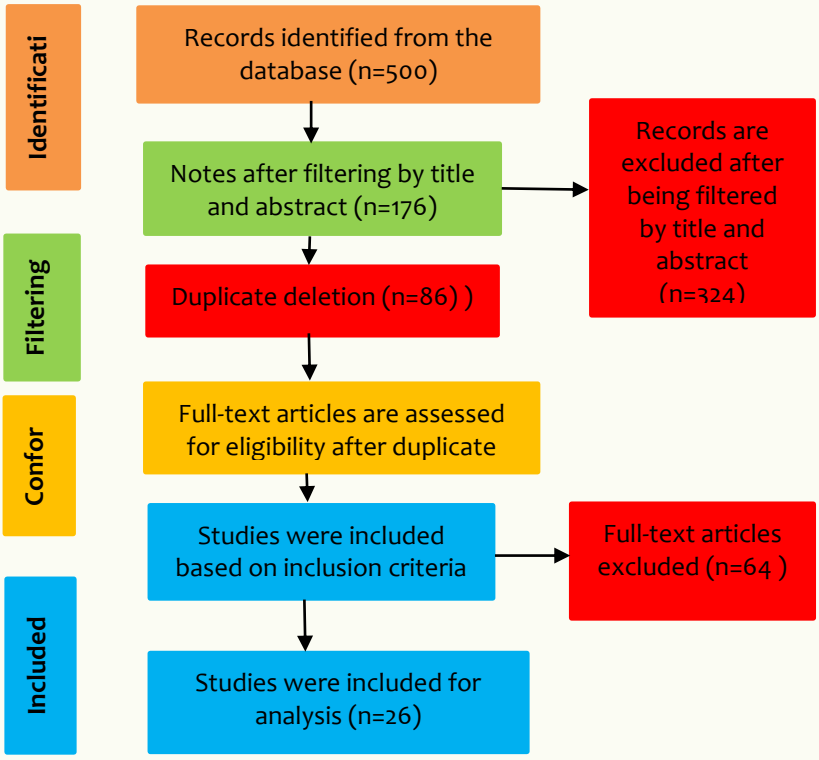

Figure 1. Diagram PRISMA

This search process produces 500 results using the Publish or Perish 8 application. Furthermore, the second stage involves screening the titles and abstracts of the selected studies. In total, this screening procedure resulted in 176 relevant papers, 86 of which were found to be duplicates when examining the screening results. The third stage includes the assessment of the eligibility of 90 selected full-text articles. This process includes reading the paper in detail and selecting a paper that fits the inclusion criteria. After this process, 26 scientific articles that met the selection criteria were considered for final extraction. In the final stage, the quality of the scientific article (n = 26) is assessed based on the research question.

3. Result and Discussion

Result

Based on the results of the analysis of the following 26 articles:

Subject

Natural sciences is a subject that is categorized as difficult to understand, especially in motion matter (Izzah et al. 2022). The results of the literature review are shown in figure 2.

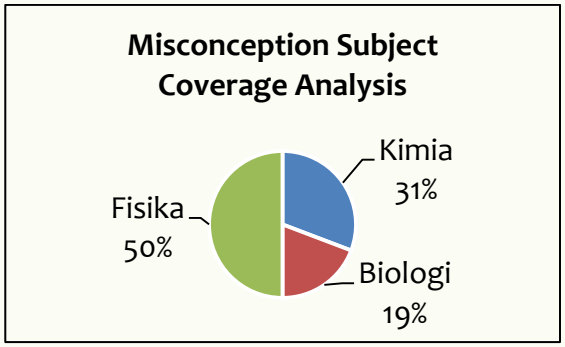

Figure 2. Results of Scope Analysis of Misconception Subjects

The results of the analysis of the most subject scope are physics with a percentage of 50% with a total of 13 articles out of 26 articles. This is because concepts in physics are often abstract and not easily connected to students' daily experiences (Lubis et al. 2023). Then the language used in physics is often different from everyday use, which can lead to confusion (Rachmawati & Supardi 2021).

Subject Matter

Learning materials are an important foundation in the educational process because they provide students with basic knowledge and understanding (Lee et al. 2024; Syahrizal et al. 2024). When there is a misconception in learning, the impact can be very detrimental and widespread. The results of the analysis of the subject matter in figure 3.

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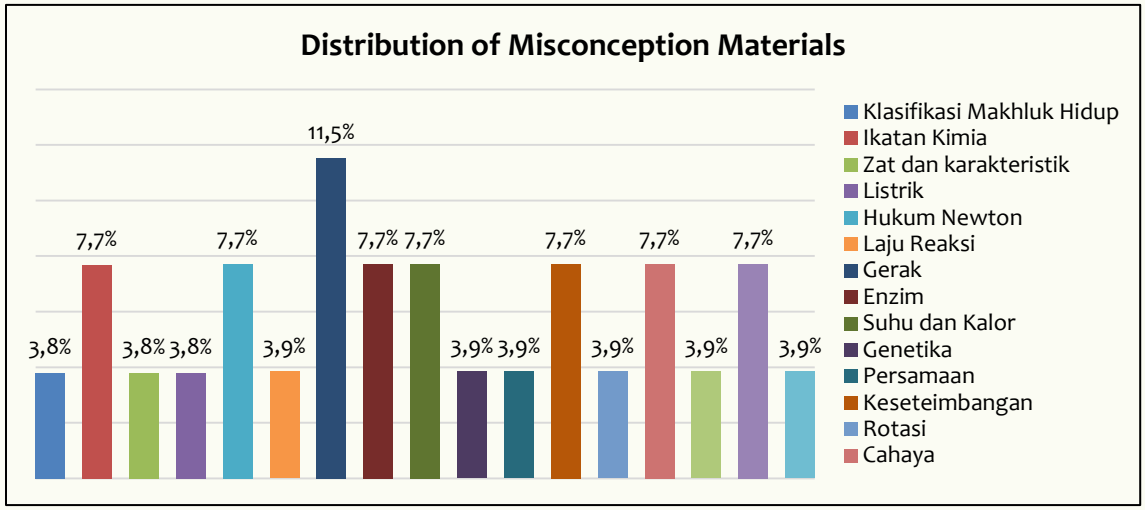

Figure 3. Results of Misconception Materials

The results of the misconception analysis on the material were the highest, which was 11.54% on motion matter. In the study (Danil, Hamdu, and Alia 2023) Analysis of misconceptions about force and motion materials in grade IV of elementary school, (Fauziah, A., & Darvina, Y. 2019) Analysis of students' misconceptions in understanding linear motion and parabolic motion materials in class X of SMAN 1 Padang, (Nasution et al. 2021) Analysis of misconceptions of elementary school students on force and motion materials. This is because movement is all abstract and often difficult to relate to students' daily experiences (Triastutik, M. 2021). The lowest misconceptions are on gravitational matter (Mariyadi & Idam Ragil 2023), pressure (Andriani et al. 2021), rotation (Asni Furoidah et al. 2017), equations (Ade Mirza et al. 2024), genetics (Amaliyah Rahayu & Suratsih Suratsih 2018), reaction rate (Fantiani et al. 2023), electricity (Didik and Aulia 2019), substances and characteristics (Mulyani et al. 2023) and classification of living things (Gultom, D.2023) with a result of 3.85%.

When Misconespi Occurred

Misconceptions that occur by year are scattered based on search articles in the figure 4.

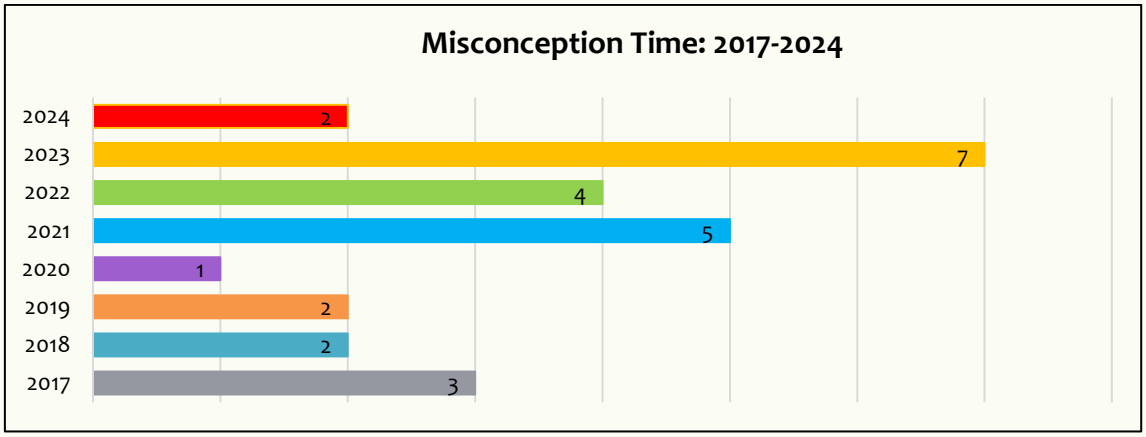

Figure 4. Results of Misconception Time Analysis

The results of the analysis of the most misconceptions are in 2023 as many as 7 out of 26 articles with a percentage of 27%. This is because in 2023 it is due to a lack of digital literacy, ineffective learning methods, changes in curriculum and syllabus, limitations in distance learning and pacsa after the COVID-19 pandemic (Rokhim, D et al. 2023 ; Oofuvong et al. 2024).

Level of Misconception

The level chosen to be analyzed is elementary and high school. It can be seen in figure 5.

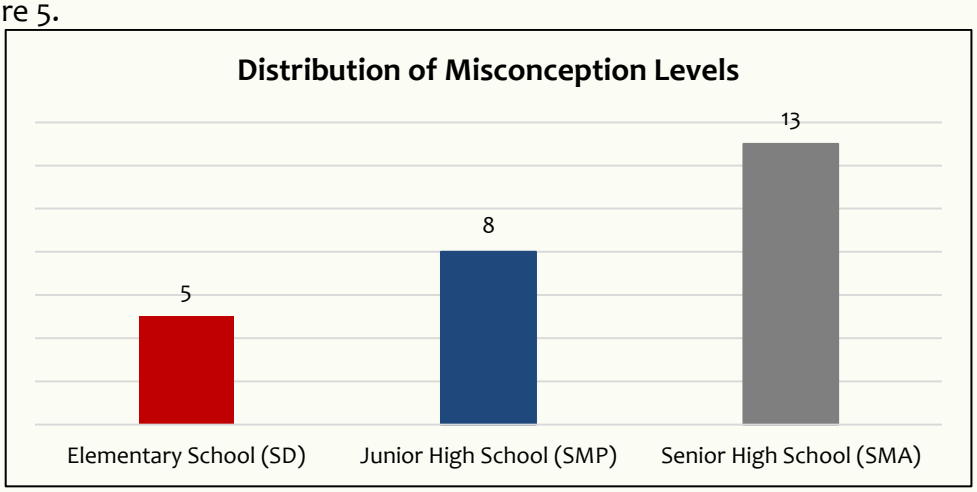

Figure 5. Levels of Misconception Level

The results of the analysis of the school level where there are many misconceptions at the high school level with a total of 50% as many as 13 out of 26 articles. At the high school level, which is the final level that is complex, there are many misconceptions in schools due to the complexity of the material, learning approach, and lack of basic understanding (Rohmah et al. 2023; Sutrisno, A. D. (2019). The lack of emphasis on basic concepts and the pressure to complete a lot of material in a limited time often make students memorize without really understanding. Varied and inconsistent learning resources and cognitive and

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emotional changes in adolescents also play a role in the emergence of misconceptions (Saputra, O., et al. 2019). In addition, the lack of opportunities for discussion and clarification in large classes and an evaluation system that emphasizes more on exam results than on conceptual understanding can exacerbate this problem (Rohmah, M., et al. 2023).

Distribution of Misconceptions

In this study, it was carried out in the area of the state of Indonesia in figure 6.

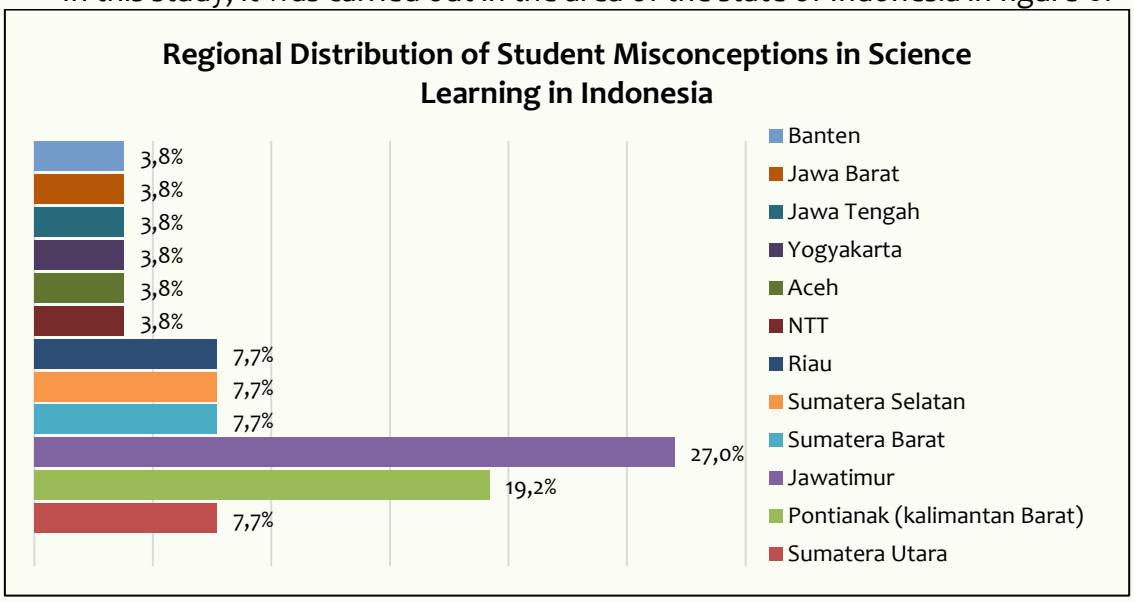

Figure 6. Areas of Student Misconceptions on Science Learning in Indonesia

Based on the results of the analysis of the spread of misconceptions about science learning, it occurs most in the East Java area by 27%, then the Pontiakan area (West Kalimantan) 27%. This is due to the lack of understanding of material concepts in teachers so that what is taught to students is not correct (Purwaningrum, J. P., & Bintoro, H. S. 2019; Kusumah and Ani 2021). Another cause is due to areas that are far from internet access technology (Aulia, A. F., et al. 2024). The total number of articles analyzed is 26 in table 2.

Table 2. Overall Articles

Heading	Article Name
Intricacies in Identification of Biological Misconceptions	Scholarly Research Journal for Interdisciplinary Studies
Analysis of Students' Misconceptions on Newton's Law Material in Class X Science of State High School 1 Berastagi	Journal of Gravity Science Physics Education
Meta-Analysis of Misconceptions of Science Students in Biology Materials at the Junior High School Level	Journal of Science Education

Analysis of Misconceptions of Grade VI Elementary School Students in Science Learning Gravitational Force Material	PENDIPA
Identification of Misconceptions of Cell Material in Students in Class XI IPA MAN 2 Padang City	LENSA (Science Lantern): Journal of Science Education
Application of the CRI (Certainly Of Response Index) *Integrated Temperature and Heat Material Science Misconception Assessment Module* through the Blended Learning Method	Bioscience: Journal of Education
Identify students' misconceptions about light matter using a four-tier diagnostic test	JIPPF: Journal of Innovation in Physics Research Education
Misconception Profile of Students Based on Bloom's Revised Taxonomy on Science Material Substance Pressure Concept	Undiksa Education Journal
Identification of Material Science Misconceptions About the Properties of Light Using the Certainty of Response Index (CRI) in Grade V Students of St. Theresia Ende Catholic Elementary School 3	NSER Journal
Analysis of Misconceptions of Elementary School Students on Style and Motion Materials	Prima Magistra: Scientific Journal of Education
Analysis of students' misconceptions in understanding linear motion and parabolic motion material in class X of SMAN 1 Padang	Education Academia
Identification of Misconceptions of the Concept of Rotational Dynamics with the Four Tier Method in Grade XI Students of SMA Negeri 3 Jember	Pillar of Physics education Scientific Journal of Physics Education
Identification and Remediation of Misconceptions with a Conceptual Change Approach to Chemical Equilibrium Materials	FKIP E-Proceeding
Misconceptions and Difficulties of Middle School Students in Quadratic Inequalities Material	Orbital: Journal of Chemistry Education
Misconceptions of Grade XII High School Students on Genetic Material Using the Certainty of Response Index (CRI) Method	Journal of Religion
Exploring Science Attitudes, Misconceptions, and Temperature Correlations	Journal of Biology Education
Exploring Science Attitudes, Misconceptions, and Temperature Correlations	Indonesian Journal of Education Methods Development
Misconceptions of Natural Science Learning (IPA) Class V in Elementary Schools	DYNAMICS: Journal of Elementary Education
Analysis of Misconceptions of Enzyme Materials Using TT-MCTE on High School Students	Scientific Periodical Biology Education

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	(BioEdu)
Analysis of Misconceptions on Force and Motion Materials in Grade IV of Elementary School	Pendas: Journal of Elementary Education
Analysis of Student Misconceptions Assisted by Certainty of Response Index (CRI) on Learning Materials Velocity and Order of Reaction	Journal of Innovation in Chemistry Education
Analysis of Students' Misconceptions on Newton's Law Material at SMA Negeri 7 Pontianak	Journal of Education and Learning
Analysis of Student Misconceptions in the Science Subject of Static Electricity Using the Four Tier Test	Research Gate
Analysis of Misconceptions of the Concept of Substances and Their Characteristics in Grade VII Junior High School Students	PENDIPA: Jurnal of Science Education
Identification and Analysis of Misconceptions in Chemical Bonded Materials Using Three-Tier Diagnostic Test Instruments	Journal of Innovative Science Education
Analysis of Students' Misconceptions in Understanding Chemical Concepts Using the TTMC Diagnostic Test	Journal IPTS
Students' Misconceptions on the Classification of Living Creatures in Class VII Private Mts. Al-Washliyah Sigambal Academic Year 2018/2019	Student Periodical Journal

The results of the analysis of student misconceptions in science learning often occur in East Java, misconceptions in science learning, especially physics at the high school level, often occur due to various factors. Limited educational resources, such as laboratory facilities and quality textbooks, as well as conventional and theoretical teaching methods, cause students to have difficulty understanding concepts in depth (Sartika, et al. 2020). (Santoso and Setyarsih 2021)The complexity of abstract physics materials that require a strong mathematical understanding, coupled with the differences in students' socio-economic backgrounds, also exacerbates this problem. In addition, the lack of teacher training in effective teaching methods and the limitations of practical experience in the laboratory hinder students from connecting theory with practice (Rizki, C., & Setyarsih, W 2022). All of these factors contribute to the high level of misconception among high school students in East Java.

Discussion

Misconceptions in science learning can significantly hinder students' learning process. The highest areas of misconception rates in science learning in East Java and Pontianak are due to a combination of a lack of understanding of concepts by teachers, limited access to technology, students' preconceptions, and ineffective teaching methods in line with the opinion of the researchers (Aulia et al. 2023) . To address these issues, it is important for educators to improve their understanding of science, utilize technology in teaching, and implement more interactive and immersive learning methods (Faznur et al. 2020). In addition, motion material in

physics learning is the highest misconception due to errors in the learning process that must be overcome through learning methods, the language used and the ability of the teacher (Aulia et al. 2023; Sihaloho et al. 2021; Utami and Dewi 2020; Yoo and Kweon 2019).

Some contributing factors include such as initial experience (Chen et al. 2020), students often have intuitive understandings of science concepts that do not always match the scientific concepts taught in school (Rodriguez and Towns 2021; Trevors and Duffy 2020). Ambiguous language, the use of unclear language in teaching can lead to confusion and misconceptions (Deiana et al. 2023; Shrestha et al. 2020). Limitations of learning methods (Rohmah, Priyono, and Sari 2023; Sihaloho et al. 2021), Non-interactive teaching methods and lack of opportunities for discussion can exacerbate this situation, especially in large classes (Dini et al. 2024; Eli 2021). Solutions to overcome the problem of misconceptions in science learning, some can be done such as teacher training (Aulia et al. 2023) to improve teachers' competence in conveying science concepts clearly and effectively (Siri et al. 2020). Then conduct active learning methods (Fajra, Syachruroji, and Rokmanah 2023; Yoo and Kweon 2019), use more interactive and discussion-based learning methods to help students understand concepts deeply (Dewi, Dewi, and Furnamasari 2021; Utami and Dewi 2020). Student reflection is providing opportunities for students to reflect on their knowledge and correct misconceptions through reflection journals or group discussions.

4. Conclusion

The results of the analysis of misconceptions about science learning in schools were 26 articles that were analyzed with the most results occurring in 2023 as many as 7 meanings of 27% then followed in 2021, 2022, 2017, 2024, 2018, 2019 and 2020. At the high school level 50%, junior high school 31%, and elementary school 19% with physics subjects 50%, chemistry 31% and biology 19% on motion matter with a total of 3 journals of 11.54%. Areas where there are many misconceptions among students in science learning are in East Java by 27% and Pontianak in West Kalimantan by 19.2%. In conclusion, this analysis research still has a high level of misconceptions among students about science learning materials at the high school education level, especially in the East Java and West Kalimantan areas of Pontianak.

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