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Misconceptions of the 6th Grade Elementary School Science Textbook

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Abstract

Science learning is learning that contains many concepts so that there is the potential for misconceptions to occur in the learning process. Science misconceptions do not only occur in students and teachers, but also in textbooks that are used as learning materials. This study aims to identify science concepts that contain misconceptions in the IPAS grade VI book. Qualitative description using a content analysis approach was used as a method to analyze the concepts presented in the grade VI IPAS book. The data analysis technique uses a reference to five types of misconceptions, namely misidentifications, oversimplifications, overgeneralizations, undergeneralizations, and obsolete concepts and terms. The results of this study revealed the existence of misconceptions found in four chapters related to science material in the IPAS grade VI book. The seven misconceptions that were found consisted of two misconceptions of overgeneralizations and five misconceptions of oversimplifications.

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INTRODUCTION

Natural and Social Sciences or better known as IPAS is a subject at school that has a crucial role in forming the basis of students' understanding of nature and its interactions, as well as how human life both as individuals and social beings interact with the surrounding environment. Science is a collection of knowledge arranged logically and systematically by considering cause and effect (KBBI, 2016). One of the sciences within the scope of IPAS is natural science (IPA). Science learning contains many concepts, so there is the potential for misconceptions to occur in the process of learning activities (Purwaningrum, 2021).

Misconceptions are defined as erroneous understandings or concepts constructed by individuals during the learning process (Kökver et al., 2024). Misconceptions can occur if the concepts formed by students during the learning process are not based on a scientific basis (Demirezen et al., 2023). Misconceptions can be triggered by several causes, including coming from the students themselves, teachers, textbooks and learning resources, context, as well as the learning models and methods used (Rohmah et al., 2023). The main cause that leads to the occurrence of misconceptions is the textbook used (Ayuni & Arif, 2023). The use of language that is difficult to understand or inaccurate explanations in books can lead to misconceptions (Zulyusri et al., 2023). Textbooks that have the potential to trigger misconceptions can build incorrect basic concepts in students that allow misconceptions to occur in more complex and enlarged concepts (Afriliska & Zulysuri, 2021).

Textbooks are an important element in education because they help teachers manage optimal learning, and support students to learn more optimally (Arif et al., 2024). Unfortunately, the current phenomenon shows that many teachers or educators do not analyze, or even realize that there are misconceptions in the books that will be taught to students, even though this can affect the learning process and understanding of material on a concept (Novianti, 2020). Textbooks used in educational institutions must pay attention to the quality of the material presented, because the quality of the content is a very important aspect to ensure the book acts as an effective teaching material for students (Afifah & Isnawati, 2023).

Misconceptions in textbooks can be divided into 5 categories, including misidentification, oversimplifications overgeneralizations, undergeneralizations, and obsolete concepts and terms (Ulfa et al., 2024). The impact of misconceptions on students will be serious in the future if not immediately corrected because they have an incorrect understanding of the concept (Syarifah et al., 2024).

Several previous studies have identified misconceptions that occur in student textbooks in science subjects. First, research on the Electronic School Book (BSE) for grade 4 SD Merdeka Curriculum shows the results of overgeneralizations misconceptions in friction force material (Arif et al., 2024). Another study revealed that five misconceptions were found in the Grade 4 Merdeka.

Curriculum IPAS Book for students, namely in the concept of photosynthesis with the overgeneralization category, and the concepts of plant body parts, pollination, muscle force, and gravitational force with the oversimplifications category (Budiwati et al., 2023). Furthermore, research on the 5th grade Independent Curriculum IPAS book revealed that there were misconceptions in concave mirror material which was categorized as misidentification (Arif et al., 2024). As well as research analyzing grade 4 science BSE books, as for the findings of this study, namely there are 8 concepts that experience misconceptions (Fadhilah et al., 2022).

Some of the results of the above studies show that there are science textbooks that contain misconceptions, so it is possible that there are similar misconceptions in other textbooks. Due to the lack of research on IPAS books in elementary schools and there is no research that specifically analyzes misconceptions in IPAS grade VI books. This gap indicates the need for research to identify potential misconceptions in the book. Therefore, this study fills the gap of previous studies by analyzing misconceptions in the IPAS grade VI book published by the Ministry of Education and Culture in 2022.

The urgency of this research is even higher considering that textbooks are one of the main learning resources for students and teachers in understanding science concepts. Misconceptions in textbooks can lead to erroneous and sustainable understanding at the next level of education. Therefore, this study aims to identify conceptual errors in the IPAS grade VI book and contribute to its improvement to be more scientifically accurate. The results of this study are expected to help educators teach science concepts more precisely and prevent the emergence of misconceptions in students. Thus, learning can take place more effectively and support better understanding of science concepts.

METHOD

This research applied descriptive qualitative method using content analysis approach. The documentation technique using the observation sheet instrument for the presence or absence of misconceptions in the content of the book was used as a technique to collect data.

The series of data analysis designs using the views of Miles et al., (2014) include the following three steps: 1) data condensation, 2) data presentation, and 3) inference or validation. In the data condensation stage, researchers prepare research data through sample selection, where in this context, the data used is the content of the IPAS Book for Grade VI of the Merdeka Curriculum published by Kemdikbudristek in 2022 in the first chapter with the theme "How Does Our Body Move?", the fifth chapter with the theme "Exploring Earth and Space", the sixth chapter with the theme "Gawat! Is it true that the energy on Earth will run out?", and the seventh chapter with the theme "Our Earth is in Danger".

At this stage, sorting data and focusing research on science concepts in textbooks to be analyzed using references to five categories of misconceptions in textbooks, namely misidentification, oversimplifications, overgeneralizations, undergeneralizations, and obsolete concepts and terms (Hershey, 2005). Misidentifications if the concept in the textbook is wrong to be identified, oversimplifications if the concept in the textbook is explained too simply, overgeneralizations if the concept in the textbook uses conclusions that are too broad from limited examples, undergeneralizations if the textbook still uses concepts with scope restrictions so that they are narrower, and obsolete concepts and terms if the concept in the textbook still uses old terms that are no longer relevant due to new findings and scientific developments. To identify misconceptions in textbooks, several indicators are used which are categorized as follows:

Table 1. Indicators Misconception Category

No	Misconception Category	Indicator
1	Misidentifications	• Connecting a concept with an incompatible term or image. • Giving an incorrect name or explanation to a structure or process. • Associating phenomena with inappropriate concepts.
2	Oversimplifications	• Explains concepts in such a simplistic way that the original meaning is distorted. • Omitting important aspects of a concept can lead to inaccurate understanding. • Does not consider factors or conditions that may affect the concept
3	Overgeneralizations	• Stating that a concept applies to all situations without excetion • Apply a principle in an inappropriate context. • Assumes that all cases have the same pattern without considering any variations.
4	Undergeneralizations	• Assuming that a concept only applies to a specific situation, when in fact it is much broader in scope. • Not realizing that the principles learned also apply in other contexts. • Ignoring variations or broader aspects of a phenomenon
5	Obsolete Concepts and Terms	• Use terms or concepts that are no longer used in modern science. • Teaches theories that have been revised or are no longer valid based on recent research. • Does not update information according to the latest scientific developments.

(Hershey, 2005)

At the data presentation stage, the data that had been sorted and collected from the textbooks were then compared with science concepts in several research journals. Comparisons were made by grouping misconception findings in textbooks based on five misconception categories. Further-

more, at the stage of drawing conclusions, data in textbooks that experience misconceptions are determined based on content discrepancies and misconception categories. The misconceptions were then further analyzed with an explanation of the reasons for misconceptions based on the appropriate misconception category indicators. In addition, suggestions for improvement, refinement of concept presentation, or reinforcement using more relevant examples are also presented.

The credibility test of the extension of observation is used to increase the credibility and validity of the results of qualitative research. Through extended observation to test the credibility of the data, researchers make observations of the data that has been obtained to ensure the truth (Mekarisce, 2020).

RESULT AND DISCUSSION

Based on the analysis of misconceptions in the IPAS book for grade VI students of the Merdeka Curriculum, especially in the chapter that discusses science, the results found are shown in the following Table.

Table 2. Results of the Analysis of Science Books for Grade VI Students of the Merdeka Curriculum Publish by the Ministry of Education, Culture, Research and Technology

No	Category	Chapter	Page	Material Concept
1	Misidentification	-	-	-
2	Overgeneralization	1	14	Reflex Motion
		5	106	Sun Motion
3	Oversimplifications	1	7	Striated and Smooth Muscle
		6	153	Energy Source
		6	156	Renewable Energy
		7	168-169	Global Warming
		7	169	Causes of Global Warming
4	Obselete concept and term	-	-	-
5	Under generalizations	-	-	-

The misconceptions that were found in the IPAS book for grade VI of the independent curriculum of the Ministry of Education, Culture and Research in 2022, especially in science subject matter, consisted of 2 categories of misconceptions. The misconception categories are overgeneralization and oversimplifications.

The first category of overgeneralization found on page 14 is that all body movements always involve full awareness and control from the brain, ignoring reflex movements that are automatic and controlled by the spinal cord.

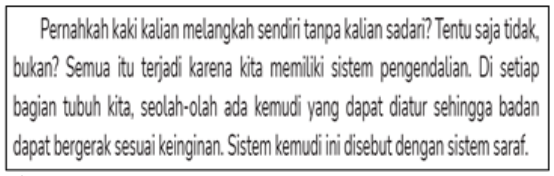

Pernahkah kaki kalian melangkah sendiri tanpa kalian sadari? Tentu saja tidak, bukan? Semua itu terjadi karena kita memiliki sistem pengendalian. Di setiap bagian tubuh kita, seolah-olah ada kemudi yang dapat diatur sehingga badan dapat bergerak sesuai keinginan. Sistem kemudi ini disebut dengan sistem saraf.

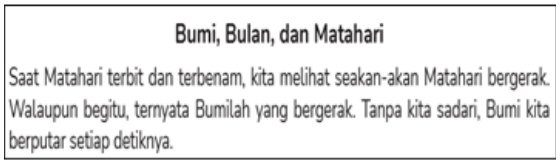
Figure 1. Nervous System

The misconception that arises in the statement "Have your feet ever stepped on their own without you realizing it? Of course not, right?" on page 14 is the assumption that all body movements always involve full awareness and control from the brain. This statement seems to deny the existence of reflex movements, which are movements that occur automatically without involving consciousness or thought.

Reflex movements, such as pulling the hand away from a hot object or away from other sources of danger, do not require the involvement of the brain in decision-making. Such movements are controlled by the spinal cord which acts as a direct link between the stimulus (e.g. the feeling of heat) and the body's response (withdrawing the hand) (Meamardoost et al., 2023). In this case, the body responds quickly without the brain having to engage in thought processes or awareness.

This misconception can cause students to fail to understand that not all body movements involve conscious thought. They may think that all body movements require forethought, whereas the body has protective systems such as reflex movements that serve to respond to danger quickly and without the need for thought. It can also hinder their understanding of the spinal cord's role in regulating reflex movements, which is different from the brain's role in conscious movements.

The second overgeneralization is found on page 106 that the Sun does not move, only the Earth moves, even though the Sun also has a movement around the center of the Milky Way galaxy.


Bumi, Bulan, dan Matahari

Saat Matahari terbit dan terbenam, kita melihat seakan-akan Matahari bergerak. Walaupun begitu, ternyata Bumilah yang bergerak. Tanpa kita sadari, Bumi kita berputar setiap detiknya.

Figure 2. Sun

The statement on page 106 states that "When the Sun rises and sets, we see as if the Sun is moving. However, it is actually the Earth that moves.". This statement could potentially lead to the misconception that the Sun has no movement at all. Students may misunderstand that only the Earth moves, while the Sun and other celestial bodies are considered stationary. In fact, the Sun also has its own movement. Besides being the center of the solar system, the Sun moves at a speed of about 828,000 km/h around the center of the Milky Way galaxy. This movement occurs together with the planets orbiting the Sun in the solar system (Sulistari, 2023). All celestial bodies, including the Sun, planets, and other stars, move in a certain trajectory in accordance with the law of gravity, thus forming a dynamic universe system (Rizal & Ridwan, 2024).

In the first oversimplefaction category found on page 7, only striated muscles are involved in defecation, without understanding the role of smooth muscles that play a greater role in this process.

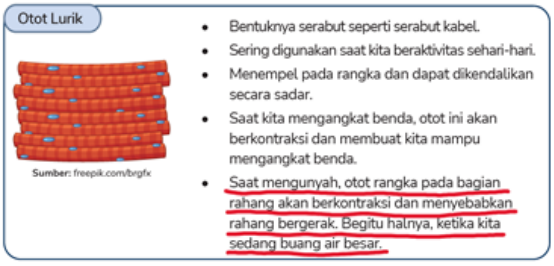


Figure 3. Striated Muscle

The statement "When chewing, the skeletal muscles in the jaw will contract and cause the space to move. Similarly, when we defecate." on page 7 introduces the concept that skeletal muscles (striated muscles) are involved in defecation. This is not wrong, but the statement does not explain the difference and collaboration of smooth and striated muscles in the defecation process. Students may misunderstand that only skeletal muscles (striated muscles) are responsible for this activity, without realizing that smooth muscles along the digestive tract play a major role.

During bowel movements, the body uses two types of muscles that work together. The first is smooth muscle, which is muscle that works automatically without the need for a command. This muscle is found in the large intestine and is responsible for pushing feces (poop) towards the anus. The second is striated muscle, which is a muscle that can be controlled consciously. This muscle is found in the anal sphincter, the part at the end of the digestive tract, and functions to hold or release feces as needed (Zulisa et al., 2021: 20). For example, when in the toilet, the striated muscle can be relaxed so that the stool comes out. However, if it is not yet in the appropriate place, the striated muscle can be tightened to hold the stool temporarily. With these two types of muscles working together, the process of defecation can take place smoothly.

The second oversimplification found on page 153 is that the Sun's energy will run out like fossil energy, even though the Sun is a renewable energy source that is expected to continue emitting energy for billions of years to come.

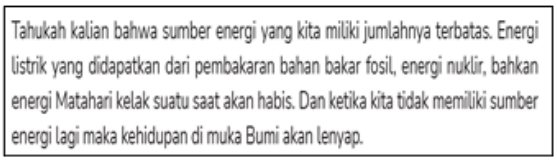

Tahukah kalian bahwa sumber energi yang kita miliki jumlahnya terbatas. Energi listrik yang didapatkan dari pembakaran bahan bakar fosil, energi nuklir, bahkan energi Matahari kelak suatu saat akan habis. Dan ketika kita tidak memiliki sumber energi lagi maka kehidupan di muka Bumi akan lenyap.

Figure 4. Solar Energy

The statement in the book that "electrical energy obtained from burning fossil fuels, nuclear energy, and even solar energy will one day run out" on page 153 contains a misconception. While fossil and nuclear energy sources are limited and may run out, solar energy is a renewable energy source that will not run out anytime soon. The Sun is expected to continue emitting energy for billions of years to come (Sulistari, 2023) . Therefore, assuming that the Sun's energy will run out like other energy sources is incorrect.

These misconceptions can lead to a misunderstanding of the importance of developing and utilizing renewable energy, especially solar energy, in an effort to sustain energy resources in the future.

The third oversimplification found on page 156 is that renewable energy can only be utilized in areas with ideal natural conditions, without considering technological advances and other factors such as government policies and investment.

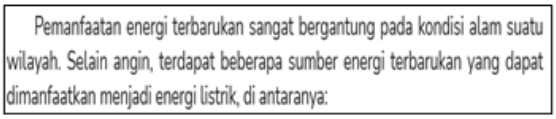

Pemanfaatan energi terbarukan sangat bergantung pada kondisi alam suatu wilayah. Selain angin, terdapat beberapa sumber energi terbarukan yang dapat dimanfaatkan menjadi energi listrik, di antaranya:

Figure 5. Renewable Energy

The statement "The utilization of renewable energy is highly dependent on the natural conditions of a region" on page 156 is not entirely correct if it is not supplemented with sufficient additional information. This statement is indeed relevant for some types of renewable energy such as hydropower, wind power, and solar power, which

are strongly influenced by the geographical and climatic factors of a region. For example, wind power plants require areas with consistent wind speeds, solar power plants require areas with high sunlight intensity, and hydropower plants require rivers with fast currents. However, this statement does not include the fact that there are other types of renewable energy, such as geothermal and biogas, which can be utilized in almost all regions with varying degrees of technological adaptation (Hakim et al., 2022).

In addition, the utilization of renewable energy is not only determined by natural conditions, but also by technological advances. The development of modern technology has allowed renewable energy to be utilized more widely, even in regions that do not have ideal natural conditions (Belva & Raspati, 2024). For example, efficient solar panels can now work optimally in cloudy areas, while the use of wind turbines with large blade diameters designed to capture wind energy at low speeds (Supari et al., 2024: 58). Energy storage technologies, such as large batteries, also allow renewable energy to be used consistently even if energy sources such as wind or the Sun are not available all the time (Lewi et al., 2024).

Furthermore, the successful utilization of renewable energy is also highly dependent on other factors such as government policies, investment, and public awareness (Lewi et al., 2024; Putri et al., 2022; Wijanarka & Dewi, 2024). Governments that provide regulations and incentives for renewable energy development can encourage the adoption of these technologies in different regions (Nasution & Azmi, 2024; Firdaus, 2022). For example, countries such as Denmark and Germany have managed to make the most of renewable energy through a combination of supportive policies and large investments in energy infrastructure (Nurtyandini et al., 2024; Yiwananda et al., 2021). Public awareness about the importance of renewable energy also plays an important role, as end users must also support energy conservation measures and transition to more sustainable energy sources (Mudhoffar & Magriasti, 2024).

If the statements in the book are not supplemented with such context, students may misunderstand that renewable energy can only be used in certain regions with ideal natural conditions. This may overlook the flexibility of the technology and the role of policy and investment in utilizing renewable energy.

The fourth oversimplification found on pages 168-169 is that global warming is entirely caused by humans, without understanding the contribution of natural factors such as volcanic activity, variations in solar radiation, and the Earth's orbital cycle.

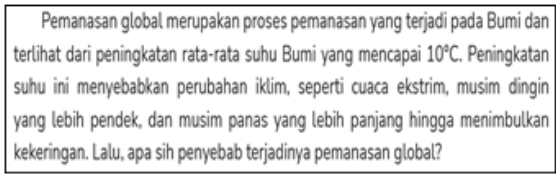

Pemanasan global merupakan proses pemanasan yang terjadi pada Bumi dan terlihat dari peningkatan rata-rata suhu Bumi yang mencapai 10°C. Peningkatan suhu ini menyebabkan perubahan iklim, seperti cuaca ekstrim, musim dingin yang lebih pendek, dan musim panas yang lebih panjang hingga menimbulkan kekeringan. Lalu, apa sih penyebab terjadinya pemanasan global?

Figure 6. Causes of Global Warming

On pages 168-169, the book states that global warming is a warming process that occurs on Earth due to an increase in pollutant gases such as carbon dioxide from human activities, such as burning fossil fuels and deforestation. While this statement is true in the context of the main causes of global warming today, the book does not explain that changes in the Earth's temperature can also occur naturally, for example through major volcanic activity, variations in the Sun's radiation, and the Earth's orbital cycle known as the Milankovitch cycle (Hari, 2019: 61).

As a result, students may misunderstand that global warming is entirely caused by humans, without considering the contribution of natural factors. This misconception can lead to an imbalance of understanding, where students blame human activities entirely without understanding the broader scientific context.

The fifth oversimplification found on page 169 is that fire is the main cause of methane emissions, without realizing that methane is also produced from various other sources such as swamps, garbage piles, and rice farming.


Penyebab lain pemanasan global, yaitu kentut sapi. Hah! Kok bisa? Ada milyaran ekor sapi di Bumi ini. Ketika sapi kentut, mereka mengeluarkan gas metana. Gas metana bersama karbon dioksida yang dihasilkan mesin terperangkap di atmosfer Bumi dan membuat suhu Bumi meningkat. Coba, kalian bayangkan berapa banyaknya gas metana yang dihasilkan kentut sapi.

Gambar 7.2 Kentut sapi mengandung gas metana, penyebab pemanasan global.

Figure 7. Causes of Methane Gas Emissions

On page 169, the book states that "there are billions of cows on Earth. When cows fart, they emit methane gas that makes the Earth's temperature rise." This statement is true that methane gas from cattle farming contributes to global warming, but it gives the impression that cows are the main cause of methane gas emissions in the atmosphere. The book does not explain that methane gas is also produced from various other

sources, such as natural swamps, decomposing organic waste piles, and rice farming which produces methane emissions through decomposition processes in flooded land (Asykiah et al., 2024; Hatta & Sulakhudin, 2016; Setiawati et al., 2024).

This lack of information may lead students to have an overly simplistic view of the causes of methane gas, blaming cattle farming as the main contributor. In addition, students may misconstrue solutions, thinking that reducing the number of cattle farms is the only way to reduce methane emissions, when organic waste management, optimizing farming systems and addressing swamps also play an important role. These errors may hinder students in understanding the complexity of the global warming problem and the importance of a holistic approach to address atmospheric methane.

Based on the results of the study, 7 misconceptions were found from the Ministry of Education and Culture's Independent Curriculum IPAS book. The findings consist of 2 misconceptions of overgeneralizations and 5 misconceptions of oversimplifications. The misconceptions are obtained from the subject matter of the nervous system and the motion system in the first chapter with 2 misconceptions, the subject matter of the rotation and revolution of the sun and the constituent materials of the earth in the fifth chapter with 1 misconception, the subject matter of renewable energy and its utilization in the sixth chapter with 2 misconceptions, and the subject matter of methane gas in the seventh chapter with 2 misconceptions.

Misconceptions about the nervous system, especially in reflex movements, are not only experienced by elementary school students, but also by high school students. Previous studies revealed that students experienced misconceptions, in the study assuming that reflex motion is controlled by the brain even though reflex motion is controlled by the spinal cord (Simorangkir et al., 2020). Furthermore, research on elementary school students' misconceptions in the concept of solar motion was also revealed by Febria et al. (2021), which revealed that some students have a wrong understanding of the motion of celestial bodies, including the assumption that the Sun does not move.

The above research is in line with Muro & Akita (2023), This study shows that smooth muscle activity can affect the shape and function of skeletal muscles during bowel movements. Then the material of energy sources in chapter 6 page 156 is written "Electrical energy obtained from burning fossil fuels, nuclear energy, even solar energy will one day run out" This contradicts the research of Dwisari et al. (2023), which states that solar energy is a renewable energy that replaces fossil fuels. The sun is a renewable energy that will not run out, and its use as renewable fuel will have benefits for the environment with reduced greenhouse gas emissions and air pollution.

Research on misconceptions on energy material is in line with that presented by Solehah et al. (2024), which revealed that some students experienced misconceptions on energy material at MTs TI Al-Madani. Then the misconceptions in the material on the causes of global warming are also expressed in researchnn Syamsuddin & Rozana (2023), found that the misconceptions experienced by students regarding the subconcept of the causes of global warming are due to differences in sources of understanding. As well as misconceptions on the material causes of methane gas emissions are in line with research Darwis & Hardiansyah (2022), which reveals some students have misconceptions that methane gas is produced from natural processes such as the decomposition of organic matter in wetlands, as well as human activities such as livestock and agriculture.

The misconceptions that are found in the IPAS grade VI book need to be followed up by re-examining the contents of the book regarding the concepts presented. Textbooks are one of the references used by teachers and students because of their function as a source of information and a basic learning tool so that they have an important role in the learning process (Ichsan, 2021). Misconceptions in the textbooks used can contribute to the occurrence of concept errors for students (Ramadhan, 2016). The results of research at SDN 1 Gatak stated that misconceptions that occurred in students originating from teaching materials reached 46.46% (Dwilestari & Desstya, 2022) Research on high school class XII biology textbooks in Kulon Progo Regency also stated that oversimplifications misconceptions were found in the textbook due to restrictions on the number of book pages (Suranti et al., 2017). The results of the textbook literature study also show that all samples of biology books used as learning resources in high schools have misconceptions with varying percentages that have an impact on difficulties in understanding new concepts (Irani et al., 2020).

The results of this study reveal that misconceptions in the 6th grade IPAS textbook of Kemendikbudristek Elementary School have an impact on the understanding and development of science literacy related to the science concepts

learned by students. The misconception findings show that some material concepts still need improvement to be in accordance with scientific principles and not cause misunderstandings for students.

The results of this study can be a study material for the government in formulating policies in the preparation, review process, and revision of textbooks both prepared by the ministry and as a reference for the community (non-government). In Regulation of the Minister of Education, Culture, Research and Technology Number 21 of 2023, it has been explained how the preparation and review of main textbooks both prepared by the ministry and the community, but it has not been accompanied by how the review process related to misconceptions in detail.

By ensuring that textbooks do not contain misconceptions, the government can improve the quality of IPAS learning and support better understanding of science concepts from an early age. This policy is certainly in line with the government's efforts to strengthen the curriculum and improve the quality of education in Indonesia.

This research was only conducted to analyze the IPAS textbook for Class VI of the Merdeka Curriculum published by Kemdikbudristek so that it does not reflect the overall textbooks used in various schools. Comparison of misconceptions is carried out with concepts in several research journals as a reference so that it is possible that not all are in accordance with the approach to learning in elementary schools.

To overcome the limitations of this study, it is recommended to expand the scope of analysis by examining textbooks from various publishers used in the independent curriculum. Research also needs to use various other reference sources such as university textbooks or international textbooks to gain a broader perspective.

CONCLUSION

Referring to the results of the misconception analysis research in the IPAS Book for Grade VI of the Merdeka Curriculum, it can be concluded that there are misconceptions in the two books used. The category of misconceptions found in 4 chapters containing material about natural science is overgeneralizations with two findings that show excessive generalizations that have the potential to distort understanding of concepts and oversimplifications with ten findings where the concepts presented in the book are too simplified so that they can reduce students' understanding of more complex material.

The implications based on this research show that the use of textbooks in learning that contain misconceptions can have an impact on the understanding and development of science literacy related to the concepts of science that students learn. The government needs to improve policies governing quality assurance in the preparation and review of textbooks, so as to minimize the presence of misconceptions in books.

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