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MISCONCEPTIONS ABOUT THE HUMAN RESPIRATORY SYSTEM: A LITERATURE REVIEW OF THE TEACHING STRATEGIES IN ELEMENTARY SCIENCE EDUCATION

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ABSTRACT

This study examines misconceptions about the human respiratory system and their implications for science instruction at the Elementary School/Islamic Elementary School (SD/MI) level. Using a literature review method, data were collected from textbooks, nationally accredited journals, and curriculum documents. Elementary school students commonly misunderstand lung function, viewing the lungs merely as air storage rather than a site of gas exchange, and frequently confuse the respiratory and digestive pathways. These misconceptions are compounded by instruction that relies predominantly on verbal explanation and rote memorization, without adequate visual or contextual support. Based on Piaget's concrete operational theory, children aged 7–11 years require tangible, observable learning experiences to build accurate conceptual understanding. The findings indicate that concrete instructional media including flipbooks, educational videos, contextual modules, and simple balloon lung demonstrations are effective in reducing misconceptions and supporting meaningful learning. It is concluded that teaching the respiratory system requires concrete, experience-based approaches rather than abstract physiological explanations, and that assessment should target conceptual understanding rather than factual recall.

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INTRODUCTION

Science Education at the Elementary School/Islamic Elementary School (SD/MI) level serves as a means for students to understand various phenomena that occur both in the environment and within the human body. One of the essential topics included in the science curriculum is the human respiratory system, which covers the structure and functions of respiratory organs, the mechanisms of inhalation and exhalation, and the process of gas exchange that sustains human life.

Understanding the concepts of respiratory organs is a fundamental aspect of science learning, particularly for comprehending the physiological processes that take place within the human body. Therefore, instruction on the respiratory system should be supported by

visual media and demonstrative activities that illustrate the processes of inhalation and exhalation, enabling students to understand the concepts more effectively (Lamalundu et al., 2024).

The topic of the human respiratory system encompasses various physiological processes occurring within the body. However, instruction on this topic often remains focused on memorizing the names of organs and their functions without adequate visual representation. As a result, students are required to construct their understanding by imagining the respiratory mechanisms being explained. This condition may lead to misconceptions, particularly regarding the concept of gas exchange in the lungs, which involves the absorption of oxygen and the release of carbon dioxide. Since this process is abstract and cannot be directly observed, elementary school students who are in the concrete operational stage often experience difficulties in developing a comprehensive understanding of the concept.

One of the major challenges in elementary science education is the presentation of subject matter containing abstract concepts. The limited use of concrete and contextual learning media may cause students to develop inaccurate understandings, which can potentially lead to misconceptions (Fadhillah et al., 2025).

According to Jean Piaget's theory of cognitive development, elementary school students are generally in the concrete operational stage, during which they are capable of logical thinking about objects and events that can be directly observed but still encounter difficulties in understanding abstract concepts. Consequently, the topic of the human respiratory system, which involves internal bodily processes, requires instructional approaches that utilize visualization and concept simplification to align with students' cognitive developmental characteristics.

Based on the implications of Piaget's theory, the learning process should provide opportunities for students to construct their own knowledge through learning activities facilitated by teachers. Therefore, science instruction should employ student-centered strategies that encourage active participation, such as discovery learning and contextual learning approaches (Mindaryani et al., 2024).

In line with these considerations, various innovative efforts have been undertaken to simplify the abstract concepts of the human respiratory system so that they can be more easily understood by elementary school students. These efforts include the development of flipbook media, educational animated videos, contextual learning modules, and interactive digital games that support the visualization of scientific concepts.

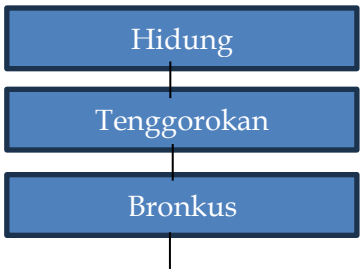
One example is the development of flipbook-based learning media for the topic of the human respiratory system, which was carried out using the ADDIE development model consisting of the stages of Analysis, Design, Development, Implementation, and Evaluation. Throughout the development process, the product underwent a series of validations conducted by subject matter experts, media experts, and instructional design experts. In addition, the media was tested with fifth-grade elementary school students to evaluate its feasibility and effectiveness in supporting science learning (Nuryani & Surya Abadi, 2021).

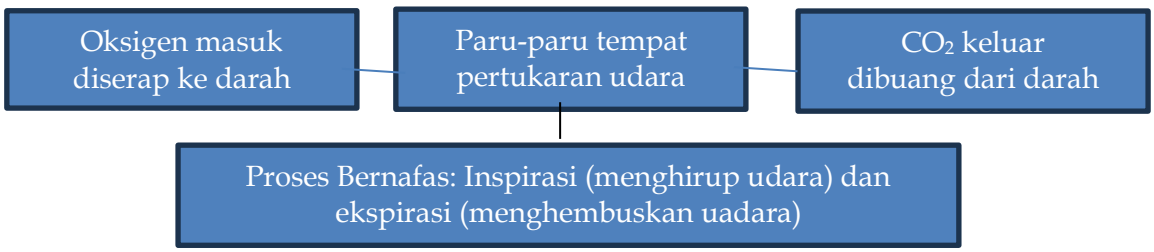
Based on the background described above, this article was prepared to examine the concepts of the human respiratory process and gas exchange, as well as to identify strategies for simplifying and presenting these concepts as science learning materials that are aligned with the learning characteristics and cognitive developmental stages of elementary school/Islamic elementary school (SD/MI) students.

This review is grounded in several key theoretical aspects: (1) an understanding of the fundamental concepts of the human respiratory system as presented in the SD/MI curriculum, (2) Piaget's theory of cognitive development, which serves as a foundation for designing science instruction that is aligned with students' developmental characteristics, (3) the use of concrete learning media and instructional methods to facilitate the understanding of abstract scientific concepts, and (4) the identification of common misconceptions that arise in learning about the organs of the human body.

At the elementary school (SD/MI) level, instruction on the human respiratory system focuses on introducing the main respiratory organs, namely the nose, trachea, bronchi, and lungs, along with their respective functions and roles in the breathing process. The material also includes an understanding of the basic mechanisms of inhalation and exhalation, through which oxygen enters the body and carbon dioxide is expelled as a by-product of metabolism. This simplification of concepts is consistent with the characteristics of the elementary science curriculum, which emphasizes the mastery of fundamental concepts and their application in everyday life rather than complex physiological and biochemical explanations.

Sistem Pernapasan Manusaia





The concept map presented in Figure 1 illustrates the respiratory system in a simplified form by organizing the content into three interconnected core elements. These elements include the pathway of the respiratory organs through which air travels from the nose to the lungs, the gas exchange process that occurs in the lungs involving the absorption of oxygen and the release of carbon dioxide, and the breathing mechanism consisting of inhalation and exhalation. Presenting the material in a visual flow format is intended to help students understand the relationships among the components of the respiratory system and develop a more concrete mental representation of the process, without requiring explanations of complex and abstract physiological concepts such as gas diffusion in the alveoli.

Piaget's theory of cognitive development proposes that children's thinking abilities progress through four major stages: the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage (Marinda, 2020). Most elementary school students are in the concrete operational stage, which is characterized by the ability to reason logically about tangible objects and observable events. However, their capacity to comprehend abstract, theoretical, and hypothetical concepts remains relatively limited (Khiyarusoleh, 2017).

The concrete operational stage, which generally occurs between the ages of 7 and 12, is characterized by the continuous development and refinement of children's thinking abilities as they grow older. Therefore, the implementation of education at the elementary school level should take into account the cognitive characteristics associated with this stage to ensure that learning activities are aligned with students' developmental capabilities, as proposed in Piaget's theory of cognitive development (Kusmiati et al., 2024; Juwantara, 2019).

The implications of Piaget's cognitive development theory for science education suggest that students should be provided with opportunities to construct their own

knowledge through active and meaningful learning experiences. Consequently, student-centered instructional strategies, such as discovery learning and contextual learning approaches, play a crucial role in facilitating effective learning processes (Magdalena et al., 2023).

In the context of teaching the human respiratory system, the application of Piaget's theory requires abstract and invisible concepts to be transformed into more concrete representations. This transformation can be achieved through the use of learning media such as respiratory organ models, demonstrations of lung mechanics using balloons, as well as simulations and role-playing activities that illustrate the movement of air through the respiratory tract. These approaches enable students to understand the concepts more easily because they are consistent with the characteristics of learners who are still in the concrete operational stage of cognitive development.

Numerous studies have demonstrated that the use of instructional media in teaching the organs of the human and animal body can improve learning outcomes, increase student engagement, and generate positive responses from learners. These findings are supported by quasi-experimental studies employing pre-test and post-test designs with control groups for comparison.

To address students' difficulties in understanding abstract concepts, the use of concrete and representative learning media has proven to be an effective solution. Various forms of instructional media have been developed and implemented in teaching the respiratory system at the SD/MI level, including printed materials such as flipbooks and learning modules, audio-visual media such as videos and animations, and interactive media such as educational games and computer applications (Karsono et al., 2019). The use of these media helps transform abstract concepts into more tangible learning experiences, making them easier for students to understand.

The development of interactive learning media based on educational games, such as *Anatomy Journey*, has demonstrated that science and social studies (IPAS) instruction that remains traditional and fails to utilize digital media effectively may result in low student engagement and difficulties in understanding the concepts related to human body organs. Therefore, interactive media serve as an alternative

instructional tool that can enhance students' interest in learning while helping to transform abstract concepts into more concrete and comprehensible forms (Ichwan et al., 2025).

In addition, studies on misconceptions related to human body organ topics indicate that students' misunderstandings may be influenced by several factors, including the predominance of lecture-based instruction, the limited use of analogies that are appropriate to students' cognitive developmental levels, and inaccuracies in the presentation of content and illustrations within learning resources used during the instructional process.

One approach that can be employed to reduce students' misconceptions regarding the structure, function, and development of living organisms, including human organ systems, is the implementation of contextual learning. This approach can be applied through the use of web-based interactive learning media and various concrete instructional materials designed to connect abstract scientific concepts with students' real-life experiences. As a result, the process of conceptual understanding becomes more effective and meaningful for learners (Haqiqi et al., 2026).

Previous studies have extensively focused on the development of various instructional media for teaching the human respiratory system at the SD/MI level, including flipbook media, instructional videos, modules based on the Contextual Teaching and Learning (CTL) approach, and interactive digital game-based media. Other studies have also examined the application of Piaget's theory of cognitive development in science and mathematics education at the elementary school level.

However, research specifically addressing the simplification of the concepts of the human respiratory process and gas exchange as science learning materials for SD/MI students remains limited. Furthermore, only a few studies have comprehensively integrated students' cognitive developmental characteristics, the analysis of common misconceptions, and considerations regarding the selection of appropriate instructional media and learning approaches within a single conceptual framework. As a result, a more comprehensive review that combines these aspects is still needed to support the effective teaching of respiratory system concepts in elementary science education.

Research Objective

The purpose of this article is to examine the concepts of the human respiratory process and gas exchange as science learning materials in elementary schools by analyzing their suitability with students' cognitive developmental characteristics. This review also focuses on identifying common misconceptions related to the topic and formulating principles for the use of appropriate instructional approaches and learning media. These principles are intended to support the delivery of the material in a concrete, contextual, and meaningful manner that aligns with the learning needs and developmental stages of elementary school students.

RESEARCH METHODOLOGY

This study employed a qualitative approach using a literature review as its research method. The data sources consisted of various written documents, including elementary science textbooks (SD/MI), literature on developmental psychology, articles published in nationally accredited journals, and curriculum documents related to the topic of the human respiratory system at the elementary school level. Data were collected through document analysis of books, scholarly journals, and relevant research findings, which were subsequently examined to develop a comprehensive understanding of the subject under investigation (Mindaryani et al., 2024).

The data analysis process was conducted through three interrelated stages. The first stage involved collecting literature relevant to the research topic, including studies on the human respiratory system, Piaget's theory of cognitive development, science instructional media for elementary schools, and common misconceptions associated with human body organ concepts. The second stage consisted of data reduction and classification, in which the findings were organized into four major categories: fundamental concepts of the subject matter, compatibility with students' cognitive developmental stages, common misconceptions, and the selection of appropriate instructional media and teaching methods. The final stage was synthesis, which involved integrating and connecting findings from various sources to construct a comprehensive conceptual understanding of the human respiratory system as science learning material for elementary school/Islamic elementary school (SD/MI) students.

The sources included in this review were selected based on their relevance to the topics of the human respiratory system and science education at the elementary school

level. The selection criteria also considered the recency of the literature, with priority given to publications released within the last decade, as well as the credibility of the sources, as evidenced by their publication in nationally accredited journals or by reputable academic publishers.

RESULT AND DISCUSSION

Compatibility of Respiratory System Content with the Cognitive Development Stage of Elementary School Students

The findings indicate that the human respiratory system content included in the SD/MI science curriculum, which is typically taught in Grade V, has been designed with consideration for the cognitive characteristics of students in the concrete operational stage. The material focuses on introducing the structure of the respiratory organs, such as the nose, trachea, bronchi, and lungs, as well as the basic mechanisms of breathing, namely inhalation and exhalation, without incorporating more complex physiological and biochemical concepts, such as alveolar gas exchange or enzymatic processes. However, classroom implementation remains largely dominated by expository teaching methods and rote memorization, limiting opportunities for students to engage in more meaningful learning experiences.

Research examining the impact of online learning on science achievement in elementary schools has revealed that a lack of instructional variety and limited face-to-face interaction during the learning process contribute to a decline in students' understanding of science concepts (Sobron et al., 2019).

The breathing process is a biological phenomenon that students can directly observe and experience, making it highly suitable for concrete and contextual learning approaches. Nevertheless, this potential is often underutilized because instruction continues to rely heavily on verbal explanations and abstract descriptions. The discrepancy between the tangible nature of the content and the predominantly abstract instructional practices highlights the need for innovation in teaching approaches and learning media that are more closely aligned with the developmental characteristics of elementary school students.

Common Misconceptions in the Human Respiratory System Topic

The literature review reveals several common misconceptions experienced by students in understanding the human respiratory system. These include the belief that the lungs function merely as a storage site for air rather than as the location of gas exchange, confusion between the roles of the respiratory and digestive systems particularly regarding the pathways of air and food, the assumption that exhaled carbon dioxide is "dirty air"

without any biological function, as well as difficulties in distinguishing the functions of respiratory organs such as the nose, trachea, and lungs due to instruction that often emphasizes rote memorization of organ names without linking them to their respective functions.

Analysis of misconceptions among sixth-grade elementary students can provide important insights into the sources and forms of students' misunderstandings in science concepts. These findings can serve as a basis for designing remedial instruction programs and developing teaching strategies aimed at reducing the occurrence of misconceptions (Mariyadi, 2023).

Early identification and correction of misconceptions are highly important. If left unaddressed at the SD/MI level, these conceptual errors may persist and influence learning at higher educational levels. This condition may hinder students' understanding of more complex topics, including the concepts of the respiratory system and cellular respiration studied in junior and senior high school.

Table 1. Pemetaan Konsep, Miskonsepsi, dan Media Pembelajaran pada Materi Sistem Pernapasan Manusia

Concepts taught	Common Misconceptions	Recommended Media/Approaches
Respiratory organs (nose, trachea, bronchi, lungs)	Students memorize the names of respiratory organs without understanding the airflow pathway; the trachea is often confused with the food pathway.	Concept maps/flow diagrams of respiratory organs; demonstration of airflow sequence using simple models
Lung function	The lungs are considered merely as "air storage" rather than a site of gas exchange.	Balloon lung model demonstration; animated videos showing lung expansion and contraction
Gas exchange (oxygen enters, carbon dioxide exits)	Carbon dioxide is perceived simply as "dirty air" with no function in the body.	Concrete analogies ("exchange of fresh air and used air"); role-playing activities of airflow movement
Breathing process (inhalation and exhalation)	Inhalation and exhalation are viewed as processes separate from the movement of the lungs/chest.	Hands-on practice of feeling chest movement during breathing; flipbooks/contextual CTL modules

Source: Processed by the author based on a literature review (2026)

Relevant Instructional Approaches and Learning Media

The review of various development studies indicates that several instructional media and teaching strategies have proven effective in bridging students' understanding

of abstract concepts related to the human respiratory system. These approaches are able to transform phenomena that cannot be directly observed into more concrete and meaningful learning experiences for elementary school (SD/MI) students.

One commonly used form of media is static visual media, such as flipbooks and illustrated modules. These materials present images of respiratory organs along with the sequential process of breathing in a systematic manner, thereby helping students construct visual representations of how air enters and exits the human body.

The development of flipbook-based learning media for the human respiratory system was carried out in response to conventional teaching methods that are often less engaging for students. Such conditions may lead to boredom and reduced concentration during learning, highlighting the need for instructional media that can enhance engagement and support conceptual understanding more effectively (Nuryani & Surya Abadi, 2021).

In addition to static visual media, audio-visual resources such as instructional videos and science song clips have also proven to be effective alternatives in elementary science education. These media integrate moving images, sound, and music relevant to the topic of the human respiratory system. Their simple, communicative, and engaging presentation helps students better understand scientific concepts while increasing their interest and participation in learning activities (Kusuma & Airlanda, 2022).

Another type of instructional media is the module developed using the Contextual Teaching and Learning (CTL) approach, which emphasizes the connection between academic concepts and students' real-life experiences. In the context of the respiratory system, this approach can be applied by linking breathing processes to daily activities, such as increased respiration rates during physical exercise.

Research on CTL-based science modules for the human respiratory system shows strong results in terms of validity and practicality. The modules received positive evaluations from subject matter experts, language experts, and instructional design experts, and demonstrated high practicality in both individual and group trials with students (Zendrato et al., 2022).

Other effective learning media include interactive digital tools, such as educational game applications that allow students to virtually explore the structure and function of human organs. The use of such media has been shown to increase student engagement, motivation, and understanding of previously abstract concepts. In addition, educational games assist teachers in transforming abstract scientific ideas into more concrete and engaging learning experiences (Ichwan et al., 2025).

In addition to digital media, hands-on demonstrations using simple teaching aids are also effective strategies for teaching the respiratory system. One example is the use of a lung model made from balloons and plastic bottles, which can visually simulate the processes of inhalation and exhalation. Research shows that the use of this balloon lung model combined with the Teaching at the Right Level (TaRL) cycle and differentiated instruction can improve student achievement in learning the human respiratory system. Through direct observation of the simulated lung function, students are able to develop a more concrete understanding of the breathing mechanism (Wahyuni et al., 2024).

Overall, these five instructional approaches and media share a common principle, namely transforming the internal and unobservable process of respiration into visual, auditory, and kinesthetic representations accessible to students' senses. This transformation enables learners to gain more concrete learning experiences in understanding the respiratory system. Such an approach aligns with the cognitive characteristics of students in the concrete operational stage as proposed by Piaget, and therefore serves as a fundamental basis for presenting the topic of human respiration and gas exchange in elementary education (SD/MI).

Implications for the Development of Teaching Materials

Based on the three aspects of the study that have been discussed, several practical implications can be formulated for the implementation of learning and the development of science teaching materials at the elementary school (SD/MI) level. First, the introduction of the respiratory process should begin with activities that allow students to gain direct experiences, such as observing and feeling chest movements during inhalation and exhalation. This approach can help students build an initial concrete understanding before learning more formal scientific concepts.

Second, content related to the respiratory organs should be presented systematically according to the pathway of air intake, namely the nose, trachea, bronchi, and lungs. A sequential presentation helps students construct a mental representation of airflow within the respiratory system.

Third, the concept of gas exchange should be explained through appropriate analogies or concrete demonstrations aligned with students' cognitive developmental level. For example, the process of oxygen intake and carbon dioxide release can be likened to the exchange of fresh air for used air, without involving overly complex physiological and biochemical terminology.

Fourth, assessment should be designed to measure students' conceptual understanding rather than merely their ability to recall facts. Therefore, evaluation tasks

may include explaining, drawing, or sequencing the respiratory process using students' own words and self-created visual representations.

CONCLUSIONS AND SUGGESTIONS

The human respiratory system is a relevant and important topic at the SD/MI level, but instructional effectiveness depends on alignment with students' concrete operational stage of cognitive development. Misconceptions—such as viewing the lungs as mere air storage or confusing respiratory and digestive pathways—persist when instruction relies on rote memorization. These can be reduced through concrete, contextual media including flipbooks, educational videos, contextual modules, and balloon lung demonstrations. Teachers are encouraged to incorporate such approaches consistently and to assess conceptual understanding rather than factual recall. Future research should examine the effectiveness of these strategies in schools with limited resources.

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