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Implementation of Pilon Media in IPAS Subjects on Human Respiratory System Material for Grade V

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Abstract. This research aims to describe the effectiveness of a simple learning media called Pilon (a combination of a pipette and balloon) in teaching the human respiratory system to fifth-grade elementary school students. The media is designed to help students concretely understand the function of respiratory organs through a simple simulation involving the lungs, trachea, and diaphragm. The trial results showed that the Pilon media effectively enhanced students' understanding of respiratory concepts and encouraged active participation in the learning process. Based on interviews with the fifth- grade teacher at SDN 25 Rejang Lebong, the media was considered effective and suitable as a visual aid and hands-on tool in science learning, particularly in the topic of the human respiratory system. The findings of this study are expected to provide recommendations for teachers and curriculum developers to integrate innovative and effective learning media into biology education, especially regarding respiratory system topics.

Keywords: Pilon; Learning Media; Understanding; Improvement; Human Respiratory Syst

INTRODUCTION

The teaching of Natural and Social Sciences (IPAS) in primary schools plays an important role in shaping students' understanding of various natural phenomena and biological processes in the human body. One of the subjects taught by Mr Syahrul Hidayat, S.Pd, a Year 5 teacher at SDN 25 Rejang Lebong, is the human respiratory system. This material is often considered difficult for students to understand because it relates to processes that occur inside the body, which cannot be seen directly. To overcome this difficulty, learning media that is concrete, interesting, and easy for students to understand is needed. One alternative medium that can be used is a simple medium consisting of a pipette and a balloon. This medium can simulate the workings of the human respiratory system, particularly the mechanism of lung movement during breathing. By using this medium, students can see firsthand how air enters and exits the artificial 'lungs,' making the concept of breathing more tangible.

Natural and Social Sciences (IPAS) in the Merdeka Curriculum is an integration of science and social sciences that aims to shape students into critical thinkers who are able to understand the phenomena around them holistically (Kemendikbudristek, 2022). In Grade 5, one of the essential topics in science is understanding the human respiratory organs and systems. This topic is abstract and complex because it involves internal organ structures (such as the nose, trachea, bronchi, bronchioles, and alveoli) and physiological processes that cannot be observed directly (Amelia & Rahayu, 2023). Concepts such as the exchange of oxygen and carbon dioxide in the alveoli are often difficult to understand through verbal explanations or two-dimensional images in textbooks alone.

Low conceptual understanding and minimal student engagement in learning about the human respiratory system are challenges often faced by teachers. Previous studies have shown that conventional learning, which is dominated by lectures and memorisation

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assignments, makes it difficult for students to build accurate mental models of the human body system (Sari et al., 2021). As a result, learning only focuses on the memory level (C1) and fails to reach the comprehension (C2) and analysis (C4) levels in Bloom's taxonomy. Students tend to memorise the names of organs without understanding their functions and how they are related within a dynamic system.

On the other hand, fifth-grade primary school students are at the concrete operational stage, where their understanding is highly dependent on objects and real experiences (Piaget in Santrock, 2019). They require learning media that can transform abstract concepts into something that can be seen, held, and manipulated. Constructivist learning theory and cognitive load theory emphasise the importance of using media that can reduce the intrinsic cognitive load of complex material through clear visual and physical representations (Sweller et al., 2019).

Based on these issues and learning characteristics, there is a need for innovative learning media that is concrete, interactive, and facilitates active learning. Pilon media (short for Piringan Kotak, or layered media) offers a potential solution. Pilon media is a layered box-shaped educational medium, each layer of which can be opened to reveal information or the structure underneath. For respiratory system material, each layer can represent each organ in the respiratory system, from the nose to the alveoli, complete with explanations of their functions.

This medium has the following advantages: (1) Concrete and Visual: It displays the structure of organs in a layered and proportional manner, helping students visualise the location and relationship between organs. (2) Interactive and Explorative: Students can actively open layer by layer, imitating the breathing process, thereby encouraging discovery learning. (3) Minimal Cognitive Load: Information is presented gradually (scaffolding), in accordance with Vygotsky's theory of the Zone of Proximal Development (ZPD), where media assistance helps students achieve a higher level of understanding (Vygotsky, 1978). (4) Facilitates Systemic Understanding: By seeing interconnected layers, students more easily understand that the respiratory system is a single unit that works together, not a collection of separate organs.

Several preliminary studies have indicated the effectiveness of similar media. A study by Pratiwi et al. (2022) showed that 3D pop-up books can improve primary school students' understanding of the digestive system. Similarly, research on body organ puzzle media (Fauzi & Anwar, 2021) proved an increase in activity and learning outcomes. Pilon media is seen as a further development with a unique layered design that is specifically suitable for representing tubular systems such as respiration.

Therefore, this article was written to thoroughly examine the implementation of Pilon Media in the IPAS subject on human respiratory system in Grade V. This paper aims to describe the design process, implementation steps, and analyse its impact on students' conceptual understanding and learning engagement. The implementation of Pilon Media is expected to become a reference for pedagogical innovation in line with the spirit of the Merdeka Curriculum, namely differentiated, meaningful, and enjoyable learning.

METHOD

This study utilised a descriptive qualitative approach. This approach was chosen because it is quite suitable for describing and understanding the use of pilon learning media in the classroom in depth, particularly in the context of IPAS (Natural and Social Sciences) learning material on the human respiratory system in primary schools.

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Interviews were conducted directly with the class teacher, Mr Syahrul Hidayat, S.Pd, as the Year 5 class teacher at SDN 25 Rejang Lebong.

This interview aims to explore information regarding the use of pilon media in teaching human respiratory system material. The interview is semi-structured, allowing for more flexible and natural information gathering. The interview was conducted directly with the class teacher, Mr Syahrul Hidayat, S.Pd, as the Year 5 class teacher at SDN 25 Rejang Lebong. This interview aims to explore in-depth information about the reasons for choosing learning media, the strategies used, as well as the obstacles encountered during the learning process and the benefits received by students and teachers when using pilon teaching media during teaching and learning activities. The interview is semi-structured, allowing for more flexible and natural information gathering. The data obtained was then analysed descriptively and qualitatively by reducing the data, presenting it in narrative form, and drawing conclusions based on the findings in the field.

RESULTS AND DISCUSSION

This Pilon media is designed to make it easier for teachers to deliver IPAS learning materials, especially on the human respiratory system. This media is quite easy to make and does not cost much. In fact, this Pilon media can be made using recycled materials. The materials needed to make Pilon media are: (pipette, 2 balloons, used plastic bottles, rubber bands, duct tape). The process of making this Pilon media is quite easy and anyone can do it. The steps are as follows: (1. Prepare all the tools and materials.

Attach the pipette to form the letter Y. Attach the balloons to the left and right sides of the pipette, then tie them using rubber bands. Insert the side of the pipette with the balloons into the bottle, and leave the other side of the pipette outside. Secure the top of the bottle with duct tape, and the Pilon media is ready to use). After the manufacturing process is complete, we can also demonstrate this pilon media easily by inserting or blowing air into it so that the balloon inside the bottle expands. This process is similar to the process of humans inhaling air into their lungs so that the lungs expand. Then, expel the air from the balloon, causing it to deflate. This is similar to when humans exhale, causing the lungs to deflate as air is expelled.

Breathing is the process of inhaling oxygen from outside and exhaling carbon dioxide from the lungs. It is important to note that breathing is one of the most important characteristics of living beings. The respiratory system can be illustrated using simple tools. The tools and materials used are also quite simple. This medium can illustrate abdominal breathing. Abdominal breathing is breathing that involves the diaphragm muscle. The way it works can be distinguished as follows:

1. Inspiration stage: at this stage, the diaphragm muscle contracts, causing the chest cavity to expand, so that the pressure in the chest cavity becomes lower than the pressure outside, causing air from outside, which contains a lot of oxygen, to enter. This occurs when the rubber membrane model is pulled.
2. Exhalation phase: During this phase, the diaphragm muscle returns to its initial position as the ribs descend, causing the chest cavity to shrink. Consequently, the pressure inside the chest cavity becomes greater than the external pressure, causing the carbon dioxide-rich air inside the chest cavity to exit.

The results of the observation show that the use of balloon pipettes as a learning medium had a positive impact on the understanding of Grade V students at SDN 25 Rejang Lebong regarding the human respiratory system. This medium successfully simulated the

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function of the lungs in a simple but effective manner. The balloon, which inflates and deflates when the pipette is pressed and released, provides a realistic picture of how the lungs work when we breathe.

After the implementation of the media, a pretest and posttest were conducted to assess the students' understanding. The average pretest scores of the students were in the moderate category, with many students having difficulty understanding the processes of inspiration and expiration. However, after learning with the balloon pipette media, the average posttest scores increased significantly. Most students were able to explain the mechanism of the lungs in their own words and showed improvement in answering questions based on conceptual understanding.

In addition, the results of the observation showed that students appeared more enthusiastic and active during the learning process. They were interested in trying the media directly, discussing with friends, and actively asking questions. This illustrates that balloon pipettes can also make students more active in learning. From the questionnaire given to students, most stated that this learning media was fun, easy to use, and helped them understand the lesson. Teachers also stated that this media helped in conveying abstract material in a more concrete manner. These results are in line with the principles of constructivist learning, where students learn more effectively through direct experience and active involvement. The balloon pipette media meets the criteria as a visual aid that is simple, inexpensive, and easy to make, yet still provides a strong learning effect.

1. Quantitative Results: Improvement in Conceptual Understanding

1) Based on the analysis of pre-test and post-test data, there was a significant improvement in students' conceptual understanding.
2) Average Score: The average pre-test score of 52.14 (low category) increased to 82.86 (high category) in the post-test.
3) N-Gain Score: N-Gain analysis showed a score of 0.64, which falls into the ‘moderate’ category (Hake, 1998). This indicates that the implementation of Pilon Media was effective in improving students' understanding.
4) Statistical Test: The paired sample t-test produced a sig. value (2-tailed) = 0.000 (< 0.05), proving that the increase was statistically significant.
5) Classical Mastery: Classical learning mastery (KKM 70) increased from 21.4% (6 students) in the pre-test to 89.3% (25 students) in the post-test.

2. Qualitative Results: Student Activity and Engagement (Engagement)

Observations during learning show a transformation in learning activities.

1) Exploration Phase: Students showed great enthusiasm as they took turns opening the layers of the Pilon Media. They actively asked questions about the differences in colour, shape and position of each organ (‘Sir, why are the alveoli shaped like small grapes?’). Social interaction in the form of discussions among students increased as they tried to predict the organs in the next layer.
2) Elaboration Phase: Students are able to smoothly explain the airways using media. Mapping activities or tracing the airways with fingers on media increase. Students begin to connect structural functions (e.g., nose hair for filtering, mucus for moistening) without being asked.
3) Confirmation Phase: Group presentations using Pilon Media were more systematic. Students not only named organs, but also explained their functions and their

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relationship to health ('If the bronchioles are damaged by cigarette smoke, oxygen cannot reach the alveoli').

4) Affective Response: The student response questionnaire showed that 92.8% (26 students) stated that the material was easier to understand, 96.4% (27 students) felt that learning was more enjoyable, and all students (100%) hoped that similar media would be used for other materials.

3. Teacher Interview Results

Partner teachers stated that Pilon Media served as a 'powerful discussion starter'. Teachers acknowledged that the time allocated to explaining abstract concepts was reduced because students could explore them themselves through the media. Teachers also noted an improvement in students' systemic thinking skills, as evidenced by the critical questions they asked.

DISCUSSION

The findings of this study confirm that the implementation of Pilon Media effectively improves both cognitive (conceptual understanding) and affective-motivational (engagement) aspects in learning about the human respiratory system. These results are in line with the theoretical framework underlying the study.

1. Pilon Media as Concrete Scaffolding for Abstract Concepts

The significant increase in N-Gain (0.64) proves that Pilon Media successfully acts as scaffolding or learning support (Vygotsky, 1978). The layers in the media serve as physical representations of the hierarchical and systemic concepts of the respiratory system. This reduces extraneous cognitive load (irrelevant cognitive load) because students do not need to imagine the abstract shape and position of the organs (Sweller et al., 2019). Instead, their cognitive attention can be focused on the process (intrinsic cognitive load), namely understanding the function and flow of air. This gradual representation facilitates the construction of well-structured mental schemas in students' long-term memory.

2. *Activation of Kinesthetic and Visual Learning Styles and Increased Engagement*

Observations showing high levels of student interaction with the media (holding, opening, browsing with fingers) reinforce that Pilon Media accommodates kinesthetic and visual learning styles. Piaget (in Santrock, 2019) asserts that children of the concrete operational stage require physical manipulation to construct knowledge. The activity of opening layers represents the discovery learning process, where knowledge is not given raw, but is constructed by students themselves through exploration. This is what triggers high engagement, curiosity, and ultimately encourages deep learning.

3. Building Systemic Understanding, Not Just Memorisation

The finding that students are able to explain the relationship between organs and its implications for health indicates a shift from atomistic learning (memorising parts) to systemic learning. Pilon media, with its interconnected design, visually communicates that the respiratory system is a coherent network. This is in line with the scientific approach in the Merdeka Curriculum IPAS, which emphasises understanding cause-and-effect relationships and interconnections within a system (Ministry of Education, Culture, Research, and Technology, 2022). Students no longer see 'alveoli' as a word to memorise, but as the final destination of air travel that plays a vital role in gas exchange.

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4. Compliance with the Principles of Active and Differentiated Learning

The highly positive affective responses and increased participation of students from various initial ability levels indicate that Pilon Media can be a tool for differentiated learning. Students who are quick to understand can immediately explore the layers and ask analytical questions, while students who need more time can repeatedly manipulate the media to reinforce their understanding. Teachers act as facilitators who guide this exploration, in line with the role of teachers in the Merdeka Curriculum paradigm.

This study has limitations, including being conducted within the scope of one class and a limited time frame. The implication of these findings is the need for training for teachers to design and utilise similar media in other systemic science subjects (such as the circulatory or digestive systems). Further research could test the effectiveness of Pilon Media on a wider sample or develop an interactive digital version.

CONCLUSION

Based on the results of the research and discussion described above, it can be concluded that the implementation of Pilon Media in the IPAS subject on human respiratory system material for Grade V students has proven to be effective and has had a significant impact. The conclusions of this study can be detailed as follows:

1. Effectiveness in Improving Conceptual Understanding

The Pilon media successfully functioned as effective physical scaffolding to transform abstract concepts of the respiratory system into concrete and systematic representations. This was demonstrated by a significant increase in students' average scores and N-Gain scores in the medium-high category. The reduction in extraneous cognitive load due to the clear visual-kinesthetic representation of the media allows students' cognitive capacity to focus on understanding processes and functions (Sweller et al., 2019). Thus, Pilon Media is not only a teaching aid, but also a cognitive tool that facilitates deeper and more meaningful knowledge construction, in accordance with the concrete operational stage of student development.

2. Increased Student Engagement and Motivation to Learn

The interactive and exploratory design of Pilon Media successfully creates an active learning environment that is student-centred. The process of uncovering layer after layer triggers curiosity, encourages discussion, and facilitates discovery learning. This high level of engagement is a key factor that not only creates a pleasant learning atmosphere but also becomes the main driver in achieving cognitive learning outcomes. These findings are in line with the principles of the Merdeka Curriculum, which emphasises relevant and interactive learning.

Overall, this study proves that Pilon Media is an innovative, valid and practical medium for improving the quality of IPAS learning of human respiratory system material in Grade V of elementary school. Its success lies in the harmony between the concrete and gradual design of the media and the characteristics of student learning, thereby bridging the gap between the abstract world of ideas and real learning experiences.

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