



Exploring Challenges in Understanding Abstract Biological Concepts: A Visual Literacy Perspective

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Abstract. This research aims to identify the difficulties that students encounter in comprehending abstract biological concepts. Through a literature review, 37 relevant articles were selected from 1225 articles in the PoP database (2020-2023). The findings indicate that abstract biology topics, such as the circulatory system, motion systems in animals and plants, genetics, and cell structure, pose challenges for students. The main constraint lies in the lack of teacher training in visual literacy, which impedes students in understanding illustrated concepts in various textbooks. Students tend to prefer cute cartoon images, which can lead to misconceptions. Therefore, it is essential to emphasize teaching methods that promote the visualization of biological concepts to help students grasp them more easily. This is crucial for improving biology education and enhancing students' visual literacy skills in the current technological era.

Keywords: Biology Material, Learning Difficulty, Visual Literacy.

1 Introduction

Natural science education (IPA) serves significant objectives in the development of students' capabilities. These goals encompass equipping students with the knowledge, skills, and attitudes required for advancing their education and facing future challenges. Furthermore, IPA learning can enhance students' curiosity [1], foster their ability to ask questions and seek answers [2], and refine their problem-solving skills regarding environmental issues in their surroundings. Through this process, students are also encouraged to develop a scientific mindset and hone their critical thinking abilities. In addition to these aspects, IPA learning aims to raise students' awareness of the interconnected relationships among natural science, technology, and society [3], [4]. IPA education, employing diverse and enjoyable approaches [3], [4], can assist students in comprehending themselves and their surroundings, as well as in cultivating scientific process skills and attitudes. Therefore, early-stage IPA management is of utmost importance to achieve these goals.

Nevertheless, there are several factors currently affecting students' academic performance in the natural science subject [5]–[7], including a lack of motivation [5], difficulty in comprehending concepts [5], [6], limited interaction with teachers [5], [6], ineffective teaching methods [5], and insufficient learning resources [5], [7]. Moreover, psychological factors such as students' interest and motivation [8], family backgrounds

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(including parental education levels and guidance) [8], as well as teachers' teaching methods, particularly if ineffective [5], and limitations in learning resources such as textbooks and science equipment [7], can contribute to students' learning outcomes. Factors associated with students themselves [9], such as difficulty in grasping concepts, poor concentration in class, and procrastination habits, can also affect low academic achievements. All these factors are essential components of students' learning experiences in natural science.

To understand and address challenges in Natural Science Education (IPA), particularly at the Elementary School level, several efforts are required. One highly valuable method is mapping based on a literature review, which can reveal the extent of research conducted by related scholars. This research has a specific objective, namely to evaluate the IPA learning materials at the Elementary School level that are considered to be of very low quality.

The research aims to describe the difficulties experienced by students, identify the factors causing difficulties in learning IPA, and analyze the efforts made by teachers and researchers to address these difficulties. Internal factors such as interest, motivation, self-confidence, and study habits, as well as external factors like the density of the curriculum, teacher dominance in the learning process, and the lack of resources, are also the focus of this research.

Furthermore, the study involves an analysis of the level of understanding of science concepts in fifth-grade students and associates it with factors such as teaching methods, lack of learning resources, and students' interest in the subject. Overall, this research comprehensively explains the challenges in IPA learning at the Elementary School level and provides in-depth insights into the factors influencing students' understanding of science concepts. A thorough literature review can provide a clear overview of the distribution of difficulties in IPA topics that are often the focus of research. Thus, through literature review, it is expected that recurring problems and challenges in IPA topics can be identified. The data generated from the literature review is anticipated to serve as a basis for designing more effective and relevant teaching strategies. Through this approach, specific student challenges can be addressed, and more efficient teaching methods can be developed to confront the learning challenges in the IPA subject.

2 Method

2.1 Problem Identification

This research employs a data collection method by accessing the PoP database, which includes 1225 journals from Scopus. The criteria for selecting journals are based on reliability and relevance, focusing on Natural Science Education (IPA) at the Elementary School level. The chosen keywords encompass issues such as learning difficulties, teaching methods, and internal as well as external factors. The careful selection of keywords ensures specific and relevant search results aligned with the research objectives. With this approach, the study can gather valid data to support the analysis of challenges in Natural Science Education at the Elementary School level.

Subsequently, the data analysis phase is carried out by sorting and extracting keywords from the search results in the database. This data is then processed using the Vos Viewer tool, which allows for detailed analysis of learning difficulties in the context of biology.

The data analysis phase is crucial in understanding the issues related to learning difficulties that appear in academic literature. The use of the Vos Viewer method to organize, visualize, and analyze the data enables the identification of patterns and trends related to biology learning difficulties.

This research phase is complemented by a conclusion phase, where a comprehensive overview and brief explanation of the analysis results are provided. In this phase, the main findings from the data analysis are summarized to provide a deeper understanding of the issues related to learning difficulties in the natural science subjects. The entire process provides a strong foundation for further understanding and addressing the issues related to learning difficulties in the context of natural science subjects.

2.2 Research Findings

In the context of in-depth research, it has successfully identified that biology content within the natural science subject often poses a significant challenge for a number of students. In the analysis conducted, it was found that some specific areas, particularly challenging for students, involve the Respiratory System, Digestive System, Cell Organelles, and various Biota. These findings have prompted the need for a more detailed examination and understanding of the aspects influencing students' difficulties in mastering these materials.

The Respiratory System, as an essential component of biology, is one of the areas that most frequently perplex students. They often encounter difficulties in understanding the terminology and processes involved in gas exchange within the body. The same applies to the Digestive System, which plays a primary role in food processing and nutrient absorption. For some students, how organs such as the stomach, intestines, and liver work together to achieve this goal remains a challenging mystery.

Cell Organelles, as fundamental components of the cell, also frequently lead to confusion. These organelles are very small but have crucial roles in cell functions. Many students struggle to correlate the function of each organelle with the overall cell.

On the other hand, Biota, encompassing a variety of organisms in ecosystems, involves complex topics such as taxonomy, ecological interactions, and adaptation. This can be perplexing for students who need to understand the diversity of living organisms and their roles within ecosystems.

The research findings have driven the search for more effective and innovative teaching approaches to address students' difficulties in comprehending these complex biology materials. A deeper understanding of the contributing factors to these difficulties will help improve the effectiveness of biology education. Therefore, it is hoped that these findings will provide a strong foundation for improvement efforts in biology education in the future.

3 Results and Discussion

The data that has been successfully analyzed and extracted from the PoP database, then processed to create a distribution map using the Vos Viewer tool, can be found in the following image. This distribution map is a visual representation of the main findings obtained from the analysis of scientific literature, providing valuable insights into learning difficulties in the context of the biology subject. The display of the research distribution conducted by various researchers can be seen in Fig. 1. below.

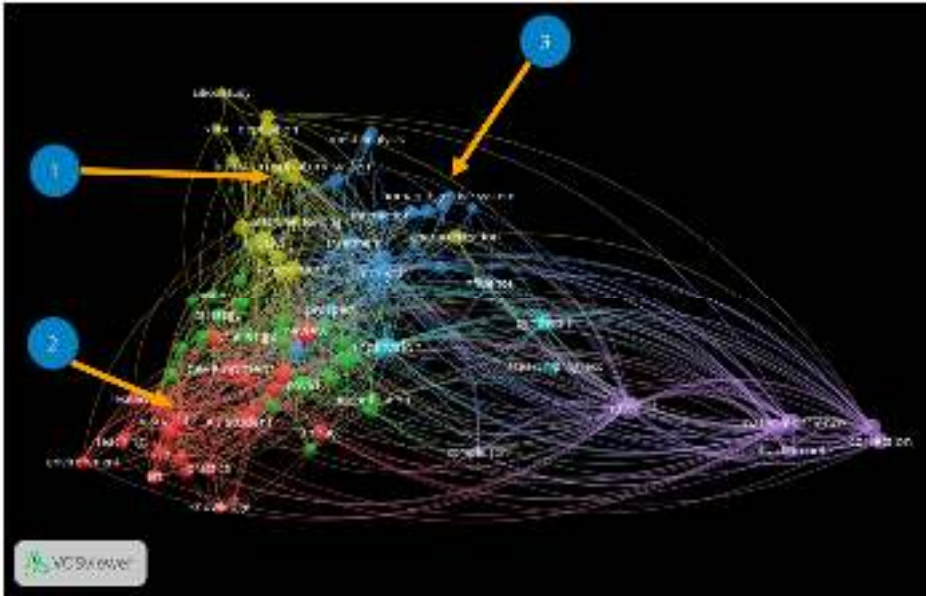


Fig. 1. Distribution of research on natural science subject difficulties

In Fig. 1, the mapping of journals from the Scopus database conducted through the PoP application has identified three main themes dominating current research: the respiratory system, visual literacy, and the digestive system. The focus of this analysis is to explore the potential connections and correlations among these three primary issues that have been the main focus of research conducted by researchers.

These findings signify the importance of the issues in the current research context and provide an opportunity to understand whether there is significant relevance or interconnectedness among the research subjects. Further analysis will be conducted to examine whether these issues have mutually influential impacts in the research context. It is hoped that the analysis results will provide valuable insights into whether the respiratory system, visual literacy, and the digestive system have interconnected relevance and implications. Next, the focus will shift to examining the distribution of themes related to visual literacy in Fig. 2. below.

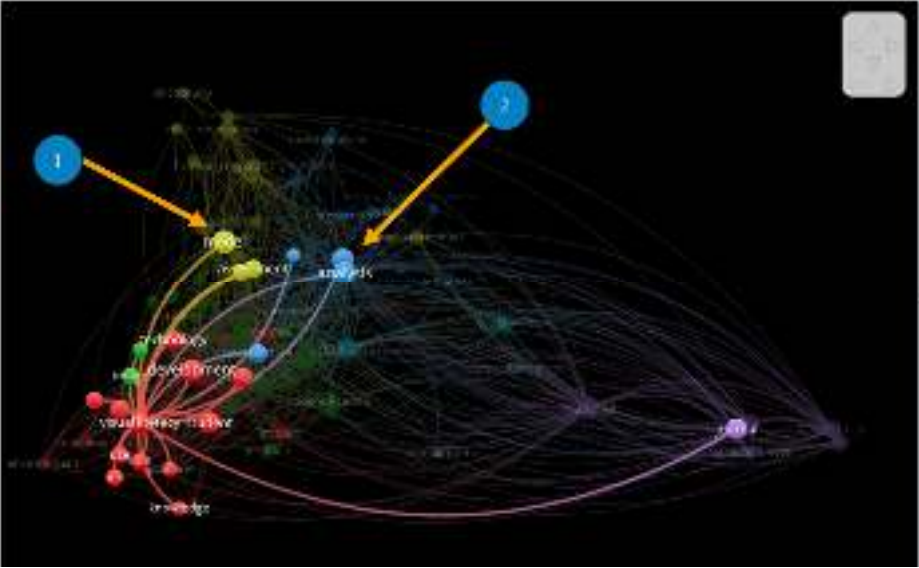


Fig. 2. Distribution of research aspects on visual literacy

In Fig. 2, concerning the context of students' visual literacy, this research focus is more directed towards the learning models applied, the assessments used in the learning process, and the analytical methods employed to measure students' visual literacy abilities. This aspect aims to gain a deep understanding of how the specific learning models used in the context of visual literacy can impact students' levels of understanding and skills in reading and interpreting visual information. It will also explore the extent to which assessments used in the context of visual literacy can affect students' learning outcomes and examine how the applied analytical methods can provide further insights regarding students' visual literacy achievement levels. Changes in the number of research themes in Vos Viewer regarding the relationship between the use of technology in the Respiratory System material can be seen in Fig. 3.

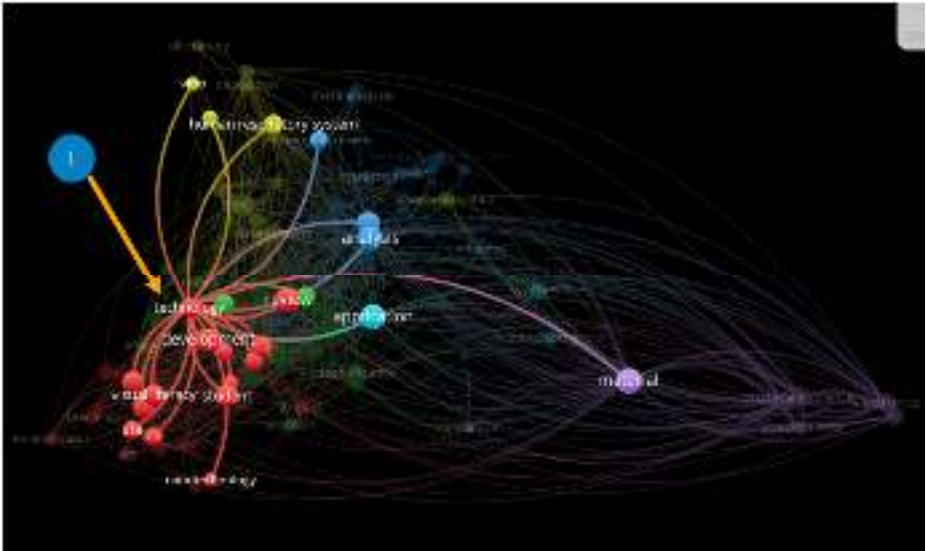


Fig. 3. Distribution of research on the implementation of technology in the respiratory system

In Fig. 3., it is evident that this literature review reveals the development of technology in efforts to enhance the understanding of the respiratory system material has been a frequently researched subject. Therefore, this opens up opportunities for in-depth analysis regarding the utilization of technology in the context of respiratory system learning with the aim of designing more effective methods to facilitate students' comprehension of this material. Distribution mapping has been carried out to examine specific research objects that are often studied regarding the Respiratory System and Digestive System materials, as seen in Fig. 4. below.

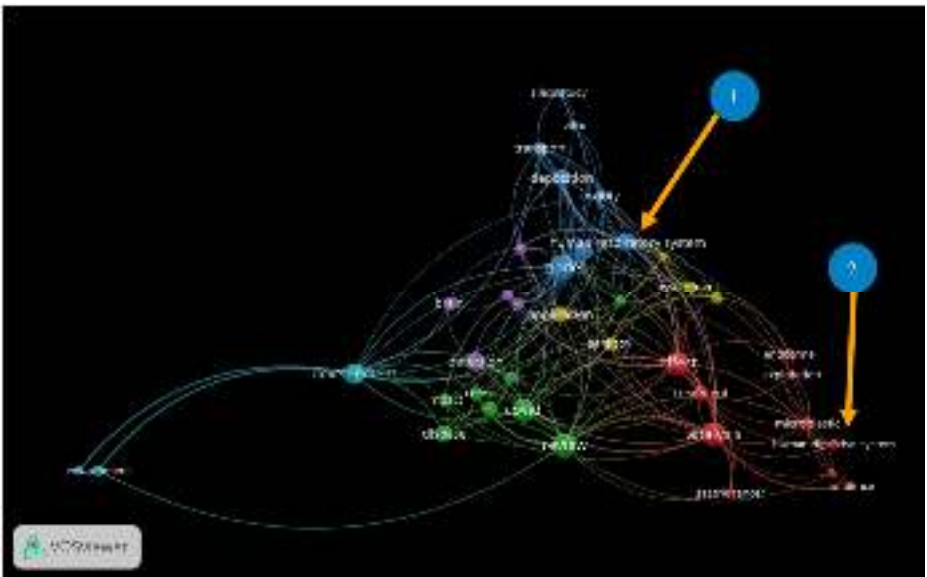


Fig. 4. Distribution of research on the respiratory system and digestive system

In Fig. 4, concerning the review related to the utilization of technology in the learning context, it was found that technology is more frequently used in relation to the respiratory system material. These findings indicate the dominance of technology utilization in learning that focuses on the respiratory system material. In this context, technology plays a significant role in facilitating more efficient teaching and learning related to the respiratory system. Further analysis will be directed towards a deeper understanding of how technology is used in the respiratory system material, its teaching methods, and its impact on students' learning outcomes. The subsequent review examines the distribution of research on topics related to the Respiratory System, as seen in Fig. 5 below.

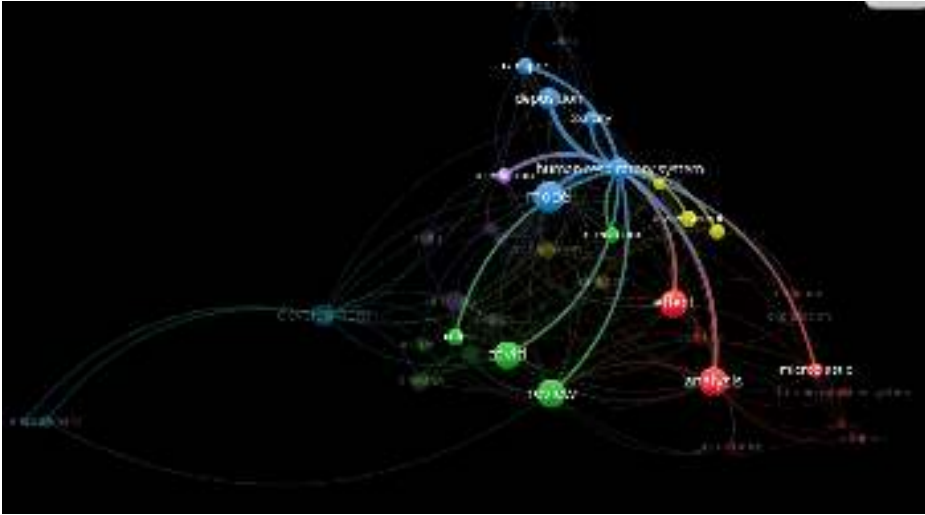


Fig. 5. Distribution of research subjects in the respiratory system

In Fig. 5, the mapping of biological materials carried out to evaluate the focused research aspects places significant emphasis on specific sub-themes within the human respiratory system material. These sub-themes encompass learning models, oxygen transport mechanisms, deposits in respiratory organelles, and other relevant aspects. Within this framework, research focusing on learning models, assessments, and health-related issues related to the respiratory system have consistently been the main research objects.

These findings reflect the importance of a deep understanding of various aspects related to the human respiratory system. By focusing on learning models and assessments, it is expected that more effective and adequate teaching methods can be identified, and suitable assessment tools can be developed to measure students' understanding. Furthermore, research on health issues related to the respiratory system can make a significant contribution in the context of health prevention and care.

The overall mapping aims to guide the development of biological education and promote more targeted and informed research efforts in understanding and addressing students' difficulties in comprehending the respiratory system material. The final

review reveals the frequently researched sub-themes in the Respiratory and Digestive System materials, as seen in Fig. 6 below.

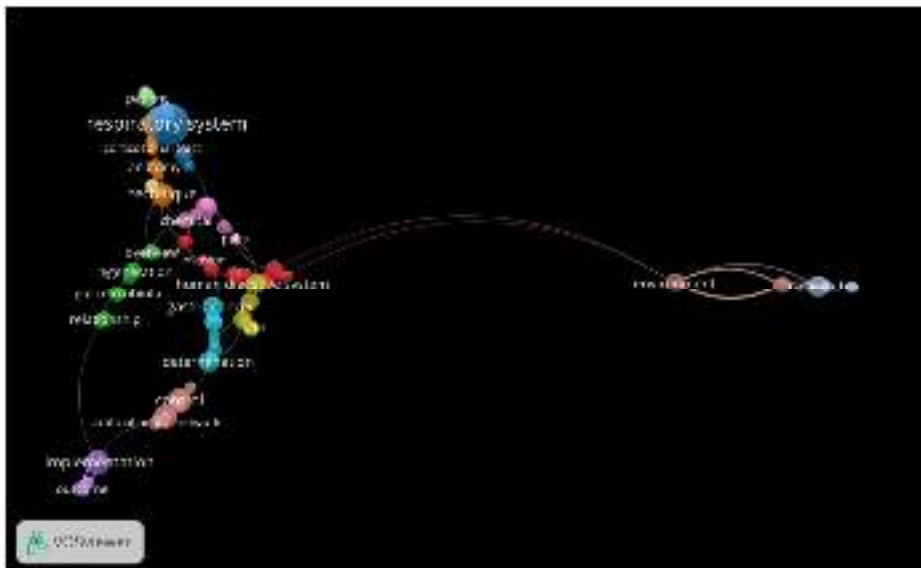


Fig. 6. Distribution of sub-themes in the respiratory and digestive systems

Based on Fig. 6, the mapping of the respiratory system materials reveals a significant interconnection between the respiratory system and the digestive system, as indicated by the red-highlighted section. This interconnection encompasses aspects such as effects, analysis, and issues related to microplastics. This analysis depicts that the broad research attention to the respiratory system material often extends its coverage to include aspects related to the digestive system.

There is a particular emphasis on disorders of the respiratory and digestive systems, indicating that in-depth investigation and understanding of disruptions and issues that may occur in both systems become a primary focus. A deeper understanding of the relationship between the respiratory and digestive systems will lead to a more holistic understanding of health and interactions within the human body. These findings can also provide a crucial foundation for the development of more coordinated educational and research strategies in the field of biology.

As a suggestion for the literature review, the analysis conducted through the PoP mapping has not reached its full potential as expected. Therefore, it is recommended to conduct further analysis using more advanced mapping analysis tools, such as Nvivo 12. This can provide deeper and more detailed insights into the issues faced by students in understanding science material, especially biology, and identify more effective solutions to overcome these challenges.

The students' understanding of the respiratory system and various sub-topics such as the Respiration Process and Oxygen Binding by Hemoglobin are often considered challenging [10]–[17]. Similarly, in the context of the digestive system, topics [18]–[27] like Nutrient Absorption, Chemical Changes, and the role of Enzymes in digestion can also be complex for students. This research indicates the need to enhance students'

understanding of these topics through the development of more effective teaching approaches.

In the development of teaching materials, it is evident that there is still a shortage of appropriate and effective teaching media used by teachers [28]–[33]. Therefore, there is a need to strengthen visual literacy as a proposed solution. By integrating visual representations into the learning process, better understanding can be achieved, particularly in complex subjects like the respiratory and digestive systems. Visual representations, especially those supported by educational technology, have the potential to improve the effectiveness of conveying these topics to students.

Hence, the use of visual representations in teaching can play a crucial role in strengthening students' visual literacy and helping them overcome difficulties in understanding the respiratory and digestive system materials. Moreover, emphasizing the use of educational technology can enable a more interactive and engaging approach to teaching, which, in turn, can enhance students' understanding of these topics.

In conclusion, the literature review conducted reveals that the difficulties in understanding biology material predominantly focus on four main areas, namely the respiratory system, digestive system, cell organelles, and various biota. Additionally, issues arise due to the underutilization of visual media in the teaching process, which can hinder students' comprehension of complex biology topics.

References

- [1] D. Darmaji, A. Astalini, D. A. Kurniawan, and F. T. Aldila, "Gender and perception: implementation of web-based character assessment in science learning," *J. Educ. Res. Eval.*, vol. 6, no. 1, pp. 131–142, 2022, doi: 10.23887/jere.v6i1.37737.
- [2] M. D. H. Wirzal, N. S. A. Halim, N. A. H. Md Nordin, and M. A. Bustam, "Metacognition in science learning: bibliometric analysis of last two decades," *J. Penelit. dan Pengkaji. Ilmu Pendidik. e-Saintika*, vol. 6, no. 1, pp. 43–60, 2022, doi: 10.36312/esaintika.v6i1.665.
- [3] A. Rasyid, M. Mustari, Y. N. Aziziy, and D. S. Nahdi, "Guided inquiry with sparkol videoscribe in science learning: a study of students' scientific attitudes," *Int. J. Educ. Innov. Res.*, vol. 1, no. 1, pp. 34–41, 2022, doi: 10.31949/ijeir.v1i1.1899.
- [4] E. Suryawati, F. Suzanti, S. Suwondo, and Y. Yustina, "The implementation of school-literacy-movement: Integrating scientific literacy, characters, and HOTS in science learning," *JPBI (Jurnal Pendidik. Biol. Indones.)*, vol. 4, no. 3, pp. 215–224, 2018, doi: 10.22219/jpbi.v4i3.6876.
- [5] Sajidan, Suranto, I. R. W. Atmojo, D. Y. Saputri, and R. Etviana, "Problem-Based Learning-Collaboration (Pbl-C) model in elementary school science learning in the industrial revolution era 4.0 and indonesia society 5.0," *J. Pendidik. IPA Indones.*, vol. 11, no. 3, pp. 477–488, 2022, doi: 10.15294/jpii.v11i3.30631.
- [6] H. Matovu et al., "Immersive virtual reality for science learning: Design, implementation, and evaluation," *Stud. Sci. Educ.*, vol. 59, no. 2, pp. 205–244, 2023, doi: 10.1080/03057267.2022.2082680.
- [7] F. Hardiansyah and Mulyadi, "Improve science learning outcomes for elementary school students through the development of flipbook media," *J. Penelit. Pendidik. IPA*, vol. 8, no. 6, pp. 3069–3077, 2022, doi: 10.29303/jppipa.v8i6.2413.
- [8] F. Simal, D. Mahulauw, M. Leasa, and J. R. Batlolona, "Self awareness and mitigation

- of learning loss on students' science learning outcomes during the covid 19 pandemic," *J. Penelit. Pendidik. IPA*, vol. 8, no. 1, pp. 239–246, 2022, doi: 10.29303/jppipa.v8i1.1172.
- [9] E. Akdag and M. S. Köksal, "Investigating the relationship of gifted students' perceptions regarding science learning environment and motivation for science learning with their intellectual risk taking and science achievement," *Sci. Educ. Int.*, vol. 33, no. 1, pp. 5–17, 2022, doi: 10.33828/sei.v33.i1.1.
- [10] I. F. Tanjung, M. S. Arilla, P. P. Sari, and V. P. Fadhilah, "Application of problem based learning strategies to overcome students learning difficulties," *Edumaspul J. Pendidik.*, vol. 6, no. 2, pp. 1867–1871, 2022, doi: 10.33487/edumaspul.v6i2.3542.
- [11] M. Adrizal, Guntur, and D. M. Pahlifi, "The use of android media in improving students' motivation in learning sports physiology," *J. Phys. Conf. Ser.*, vol. 1440, no. 1, 2020, doi: 10.1088/1742-6596/1440/1/012075.
- [12] A. A. Myanda, M. P. Riezky, and M. Maridi, "Development of two-tier multiple-choice test to assess students' conceptual understanding on respiratory system material of 11th grade of senior high school," in *International Journal of Science and Applied Science: Conference Series*, 2020, p. 44. doi: 10.20961/ijsascs.v4i1.49457.
- [13] K. Wulansari and I. Irdawati, "The Effectiveness of STEM-Based high school biology e-module on respiratory system material to improve student learning outcomes and creative thinkingthe effectiveness of stem-based high school biology e-module on respiratory system material to improve student learning outcomes and creative thinking," *Int. J. Soc. Sci. Hum. Res.*, vol. 06, no. 05, 2023, doi: 10.47191/ijsshr/v6-i5-18.
- [14] L. Luzyawati, I. Hamidah, A. Faudzan, and E. Wiyati, "Lesson study to improve students' scientific literacy abilities on respiratory system material," *J. Penelit. Pendidik. IPA*, vol. 9, no. 8, pp. 6626–6633, 2023, doi: 10.29303/jppipa.v9i8.3806.
- [15] K. Kasmanah et al., "Succeed or failed: Diagnostic of student's ability to passed basic learning material on liquid pressure, respiratory system and its application based on integrated sciences test in school," *J. Phys. Conf. Ser.*, vol. 1157, no. 2, 2019, doi: 10.1088/1742-6596/1157/2/022019.
- [16] D. S. Tinendung, "Development of E-Module based on problem based learning by using adobe flash professional cs6 on the material of human respiratory and excretory systems for students of class VIII SMPN 25 Padang," *Int. J. Curr. Sci. Res. Rev.*, vol. 05, no. 08, 2022, doi: 10.47191/ijsr/v5-i8-16.
- [17] P. P. Putri and R. Raharjo, "The development of solo taxonomy based assessment instrument on human respiratory system to measure thinking skills and mastery of concepts," *Berk. Ilm. Pendidik. Biol.*, vol. 9, no. 2, pp. 252–258, 2020, doi: 10.26740/bioedu.v9n2.p252-258.
- [18] T. Lestari and V. Oktaviani, "Analysis science process skills of grade viii students on digestive system material," *Biosfer*, vol. 16, no. 2, 2023, doi: 10.21009/biosferjpb.31731.
- [19] K. Khairuna, "STEM-based worksheet on digestive system material to improve students' creative thinking skills," *J. Biolokus*, vol. 6, no. 1, p. 25, 2023, doi: 10.30821/biolokus.v6i1.2524.
- [20] J. Tanjung and H. S. Harahap, "Animation-based learning motivation analysis on human digestive system material to evaluate students' Motivation," *Lect. J. Pendidik.*, vol. 14, no. 2, pp. 224–235, 2023, doi: 10.31849/lectura.v14i2.14409.
- [21] R. D. Fachrin and L. Dj, "Development of interactive media in science learning on human digestive system material for junior high school student grade 8th," *Universe*, vol. 2, no. 1, pp. 84–92, 2021, doi: 10.24036/universe.v2i1.60.
- [22] N. N. E. Juniarti, G. W. Bayu, and I. G. W. Sudatha, "Animation media on human digestive system material for fifth-grade elementary school students," *Int. J. Elem.*

- Educ., vol. 5, no. 2, p. 488, 2021, doi: 10.23887/ijee.v5i3.37493.
- [23] N. D. Ravista, Sutarno, and Harlita, "An analysis of the need for developing e-module based on problem based learning utilizing virtual laboratory on the digestive system material," Proc. 6th Int. Semin. Sci. Educ. (ISSE 2020), vol. 541, 2021, doi: 10.2991/assehr.k.210326.090.
- [24] G. Indriana, M. Silitonga, and F. Harahap, "The Influence of learning style on science process skills and student learning outcome of digestive system material," J. Pendidik. Indones., vol. 2, no. 6, pp. 1024–1031, 2021, doi: 10.36418/jpendi.v2i6.194.
- [25] I. W. Merta, I. P. Artayasa, and J. Juliastari, "Effect of project-based learning with the science, technology, and society approach on digestive system material against the concept mastery," in Jurnal Penelitian Pendidikan IPA, 2022, pp. 2879–2882. doi: 10.29303/jppipa.v8i6.2406.
- [26] M. Rahmi and N. Nari, "Development of inquiry-based e-poster media on natural science learning digestive system material in elementary schools," J. Islam. Educ. Students, vol. 2, no. 2, p. 76, 2022, doi: 10.31958/jies.v2i2.5609.
- [27] N. F. Sari, A. S. Putri, I. F. Rahma, E. R. Hsb, S. S. Simamora, and M. Wahyuni, "Analisis kesulitan belajar siswa di SMA Negeri 2 Bilah Hulu," J. Pembelajaran Dan Mat. Sigma, vol. 8, no. 2, pp. 555–561, 2022, doi: 10.36987/jpms.v8i2.3828.
- [28] S. Angreni, R. T. Sari, and I. Masyitah, "Development of augmented learning media reality for students learning difficulties in elementary school," J. ICSAR, vol. 7, no. 2, p. 271, 2023, doi: 10.17977/um005v7i22023p271.
- [29] D. W. Sasongko, T. Kuat, and M. Sayuti, "The Influence of competence in utilizing learning media, managing class, and diagnosis of students' learning difficulties on teaching performance of visual communication design teachers of vocational schools in Yogyakarta," J. Vocat. Educ. Stud., vol. 6, no. 1, pp. 138–146, 2023, doi: 10.12928/joves.v6i1.7631.
- [30] D. A. Dewi, J. Julia, and C. Jonathan, "Digital training in building chatbot-based online learning media: action research for teachers in semarang city through the 'train the teachers' training," Mimb. Sekol. Dasar, vol. 9, no. 1, pp. 188–208, 2022, doi: 10.53400/mimbar-sd.v9i1.44460.
- [31] E. A. Siregar and Y. Kurniawati, "The Analysis of students' mental models using macromedia flash-based learning media on molecular shapes lesson," J. Inov. Pendidik. Kim., vol. 16, no. 1, pp. 47–52, 2022, doi: 10.15294/jipk.v16i1.29869.
- [32] Yustina, W. Syafii, and R. Vebrianto, "The effects of blended learning and project-based learning on pre-service biology teachers' creative thinking skills through online learning in the COVID-19 pandemic," J. Pendidik. IPA Indones., vol. 9, no. 3, pp. 408–420, 2020, doi: 10.15294/jpii.v9i3.24706.
- [33] H. Hadriana, "Self-efficacy and Attitude of the Teachers of SMAN Kuansing District towards the Utilization of ICT," J. Educ. Sci., vol. 3, no. 1, p. 25, 2019, doi: 10.31258/jes.3.1.p.25-37.

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