



## Utilizing Learning Media in Biology: A Step Towards Interactive Media Development

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### ABSTRACT

*The study addresses the complexities inherent in teaching and learning biology, a subject that is often challenging for students due to its intricate concepts. Focusing on the intersection of pedagogy and technology, this research evaluates the perceptions of high school teachers and students towards the integration of contemporary learning media in biology instruction. Utilizing a descriptive and quantitative approach, the research engaged a purposively sampled cohort of educators and learners to explore their views. This study involved 56 teachers and 133 students spread across several schools. Data were gleaned through a combination of structured questionnaires and interviews, subsequently subjected to quantitative analysis. The findings reveal a consensus on the critical role of media in facilitating biology education. Teachers and students agree that technology-based media can improve understanding of biological concepts and strengthen student engagement. While there is a significant reliance on media to convey biological concepts, the findings indicate that the potential of technology-based media. However, the study uncovers a lag in the effective deployment of technological resources, with interactive multimedia being underutilized by a notable fraction of educators. This gap underscores the need for enhanced strategies to foster the adoption of technology-enhanced learning tools in the biological sciences.*

**Keywords:** *interactive, multimedia, science, technology*

### INTRODUCTION

In the wake of the 21st century, education systems worldwide have been confronted with the exigent need to evolve and cater to an era marked by technological innovation and global interconnectivity. Skills such as critical thinking, creativity, and digital literacy have become indispensable. Yet, in Indonesia, the educational infrastructure struggles to keep pace with these demands (Chiappe, Ternent de Samper, Wills, & Restrepo Uribe, 2020; Yoke et al., 2019). The 2012 and 2018 PISA results underscore this challenge, revealing that Indonesian students lag significantly behind the OECD average in reading, mathematics, and science. This persistent underperformance not only highlights a disconnect between the global educational standards and local learning outcomes but also raises concerns about the preparedness of Indonesian students to thrive in a competitive, knowledge-based global economy.

The prevailing instructional methodologies in Indonesian classrooms often emphasize rote learning and memorization, a stark contrast to the dynamic, analytical, and collaborative skills

championed by 21st-century educational paradigms. While the world moves towards embracing educational technology and interactive learning, many Indonesian schools are mired in traditional pedagogies that fail to stimulate students' intellectual curiosity or develop their practical problem-solving abilities (Hidayatullah, Wilujeng, Nurhasanah, Gusemanto, & Makhrus, 2021). This dichotomy between the rapidly changing skillsets required by contemporary workplaces and the static nature of education provided to the youth of Indonesia creates a widening skills gap – one that the current educational reforms seek to bridge by advocating for the integration of technology-enhanced learning strategies that promote active engagement and real-world relevance.

Ideally, the education system should be able to educate individuals in accordance with changing times and community needs. Students are expected to acquire the skills needed according to their age through education. The skills currently accepted are those that require the use of intelligence, such as higher-order thinking, generating ideas, creating products, causal thinking, and solving problems at hand. Intelligence is considered as an important factor that determines the differences between individuals and it has the ability to influence learning (Prochazkova, Novotny, Hancarova, Prchalova, & Sedlacek, 2019). Many children with low learning levels experience learning delays, cannot fluently express ideas, and even affect their learning and understanding (Brophy, 2004).

The results of the 2012 PISA (Program for International Study Assessment (PISA) study on the quality of education show that Indonesia is one of the countries with a low ranking, ranking 64 out of 65 countries. In 2018, students in Indonesia scored lower than the OECD average in reading, mathematics, and science at 74 out of 79 countries. Thus far, improvements in the results of the PISA assessment have not undergone significant changes. This can be seen from the results of the latest PISA assessment, namely Indonesia's ranking consistently in the bottom 10 countries participating in the assessment (Know & Do, 2019; Reimers, Schleicher, Saavedra, & Tuominen, 2020).

21st century education demands mastery of creative skills, skilled at using technology, so that the learning carried out must be creative and innovative. Teachers' skills in using strategies and techniques in learning practice can support the classroom environment, considering the needs of students and the comfort of the classroom environment to improve the quality of learning. The quality of learning is supported by learning practices regarding what and how teachers teach students (Retnowati, E., Suprpto, , Jerusalem, M., Sugiyarto, K., & Wagiran, 2019). Teachers are the key to success in creating effective learning because they are responsible for enforcing learning rules in the classroom (Guskey, 2002). Besides being able to collaborate with other teachers, teachers are also required to be able to utilize knowledge, technology, and information to carry out their work.

The various learning barriers experienced by children are influenced by various factors. One reason is that the subject matter is difficult to understand (Kastaun, Meier, Küchemann, & Kuhn, 2021). Many studies have shown that students in many disciplines have difficulty learning how to solve complex problems. For example, in biology, students often omit important information, remember incorrect information, or apply incorrect information to a problem (Avena & Knight, 2019). Based on observations in schools, it is known that at this time, there are still many students who are not actively involved in learning activities and cannot bring up the skills needed in this century. In fact, students are more likely to memorize the concepts provided as test preparation materials. Therefore, the ability of students to analyze and solve authentic problems has not been trained and they cannot provide optimal results, so that the lessons obtained do not become more meaningful.

Teachers must have the ability and skills to develop their students' creativity, which is the ability to generate novelty based on data, information, or other things that already exist (Anderson, Bousset, Katz-Buoincontro, & Todd, 2021). Students' perception of teacher pedagogic

competence is an important aspect in increasing student motivation and learning outcomes, because teacher pedagogic competence directly affects students' learning management activities.

This research holds critical significance for the field of education in Indonesia, particularly when considered against the backdrop of the nation's performance in the Programme for International Student Assessment (PISA). Indonesian students' scores, consistently trailing behind the OECD average, are a clarion call for educational reform (Afandi, Sajidan, Akhyar, & Suryani, 2019). This gap not only signals a need for change but also presents an opportunity to reevaluate and enhance learning methodologies. Interactive learning emerges as a promising solution, with the potential to revolutionize the educational landscape. By shifting the focus from traditional rote learning to a more engaging, participatory model, interactive learning can help cultivate the complex problem-solving skills and innovative thinking that are quintessential for success in the 21st century. In a country striving to improve its global educational standing, this research explores the transformative power of interactive media to elevate student engagement and learning outcomes, marking a vital step towards educational advancement in Indonesia.

Based on this background, the research questions were described. How do teachers and students perceive biological materials? How do teachers and students perceive the use of learning media? How are related materials and learning media used in learning?

## **METHODOLOGY**

This study aims to evaluate the use of learning media in biology learning in secondary schools. The methodology of this study is a quantitative descriptive research. Participants were selected through a purposive random sampling strategy consisting of high school science teachers and science students who participated in biology learning by the teacher. They are parties who are directly involved in the learning process and have direct experience with the use of learning media.

Overall, this study involved 56 teachers and 133 students spread across several schools. Of the 56 teachers who participated, 10 of them were men and 46 women. These teachers were selected because they have at least three years of experience teaching biology, so they are considered to have enough knowledge and insight into the effectiveness of using learning media in the teaching process. Meanwhile, the students consisted of 37 men and 96 women.

The data collected in this study is divided into two types: main data and supporting data. The main data was obtained through a closed questionnaire, which contained questions about the perception of teachers and students towards the use of learning media. This data is used to determine patterns, trends, and the level of utilization of learning media. To complement it, structured interviews are conducted to dig into the reasons behind their opinions, providing deeper insights and not just limited to measurable answers from questionnaires.

Supporting data includes information about the type of learning media used, how often it is applied, and the obstacles faced by teachers and students during its use. This data was collected through open-ended questions on questionnaires and interviews. This information is important to understand the context that affects the effectiveness of learning media, such as the availability of technological facilities, school support, and participants' technical abilities.

The data collection process was carried out from October to November 2021. This time selection aims to avoid distractions such as school holidays that can affect participants' responsiveness. The data obtained from the questionnaire were statistically analyzed to identify patterns and trends. Meanwhile, the interview data was analyzed thematically to get a richer view of the participants' experiences. With the combination of these two types of data, this study is able to provide a complete picture of the use of learning media in biology teaching.

## RESULT AND DISCUSSION

The use of learning media in biology education plays an important role in increasing the effectiveness and interactivity of the teaching-learning process. As learning is often considered complex, biology requires innovative approaches to help students understand abstract and complex concepts. This study evaluates how learning media is used in high schools, with the aim of identifying the level of utilization, user perception, and challenges faced. The results obtained provide important insights to direct the development of interactive learning media that are more relevant to the needs of students and teachers.

The discussion of the research results focuses on three main aspects. First, the level of utilization of learning media in biology classes, which includes the types of media that are most often used and how they are used to support the teaching-learning process. Second, the perception of teachers and students on the effectiveness of existing learning media, including its advantages and disadvantages. Third, the main challenges faced in integrating learning media, such as limited facilities, time, or technical skills.

Through these findings, the research not only sheds light on the current situation, but also offers data-driven recommendation to encourage the development of more interactive biology learning media. This research also aims to inspire innovation in the field of education by utilizing technology to create a more engaging and immersive learning experience for students.

Based on the data obtained from teachers and students, it is shown that Perception of Difficulty in Biological Material (Figure 1).

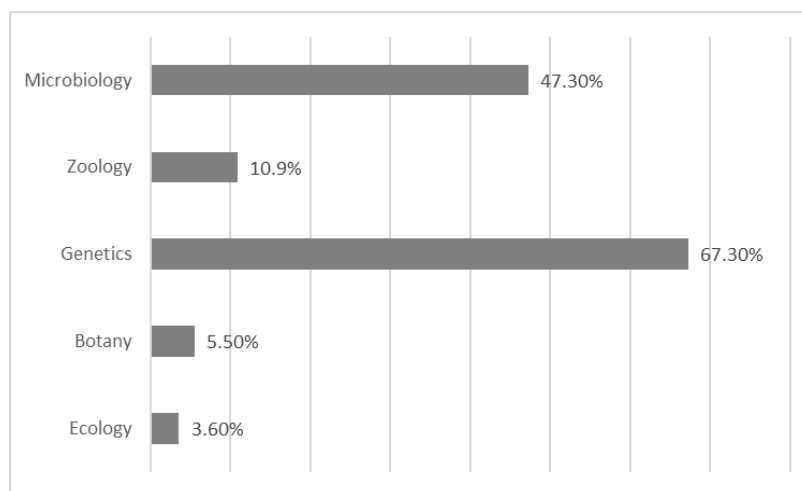


Figure 1. Perception of Difficulty in Biological Material

Figure 1 is a category of biological fields of study that are assessed from the level of difficulty. The figure shows that Genetics dominates the highest percentage. This shows that this topic is a concept that has a high level of difficulty in learning biology. This can be due to the importance of genetics in understanding various aspects of life, including health, biotechnology, and evolution, thus requiring a learning medium that supports the understanding of complex concepts such as inheritance of traits, gene expression, and genetic material.

Microbiology is in second place which shows that the concepts within this concept are considered difficult. Interactive learning media is indispensable to help students understand concepts such as the structure of microorganisms, disease mechanisms, and laboratory techniques that are often not directly observable.

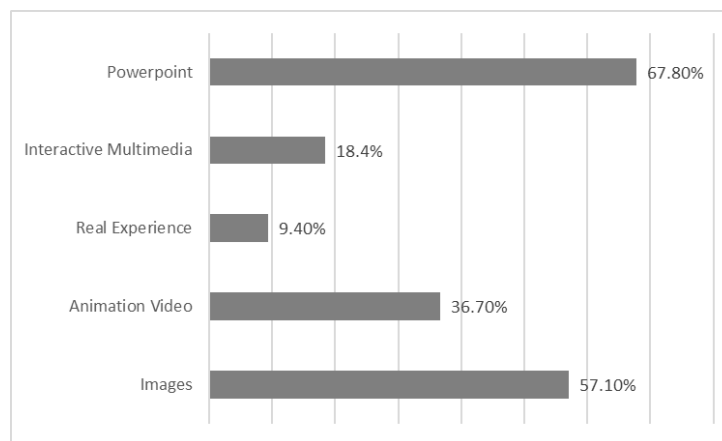
Zoology and Botany are considered not as difficult as the concepts of genetics and microbiology. Nonetheless, visual media such as videos, images, or virtual simulations can help increase students' interest and understanding of animal and plant studies. Ecology is considered to

be dancing and not very difficult because it involves complex interactions between organisms and the environment. Ecosystem simulation-based learning media can be an effective tool in learning this concept.

The importance of using diverse learning media in biology learning, especially on topics such as genetics and microbiology that require tools to visualize abstract concepts. The development of interactive and technology-based learning media can help students overcome difficulties in understanding complex topics and increase their engagement in biology learning.

Biology is known to have many abstract concepts that require teaching tools. Therefore, teachers have long used various learning media tools. Teachers have long used learning. So far, teachers have used learning media in the form of pictures to explain abstract concepts. However, amid technological advances, the use of technology-based learning media seems to require attention. Multimedia information is presented using computer aids in several forms. The use of text, images, animation, video, and sound are combined so that the information presented can help students imagine concepts better (R E Mayer, 2021; Richard E. Mayer, 2011; Meyer, Omdahl, & Makransky, 2019; Nagmoti, 2017).

The next finding shows that many teachers used Microsoft PowerPoint as the media. The next media that is also widely used by teachers in teaching biology are textbooks and pictures. Meanwhile, the least used medium was realia media (Figure 2).



**Figure 2. Students' Perceptions of Using Learning Media in Biology Material**

The use of media in learning is one of the determinants for improving the quality of learning in accordance with the material being taught. Utilizing technology significantly improves the quality of learning and learning achievement. The application of new technologies, such as computer multimedia and the Internet, can help students achieve learning achievements and realize improvements in teaching quality. Changes in learning patterns to become more innovative require special knowledge and management, so that learning can be useful for students and effective in its management.

The demands of technological development are very rapid, and teaching and learning processes cannot be separated from digital media. The education system in Indonesia at every level has taken advantage of the available digital media, especially during the Covid-19 pandemic. This is done so that the learning continues well. Nevertheless, many teachers and students still do not know the right digital media to use in learning. Other research found that through the use of digital media, which are commonly used in their daily lives, they can strengthen digital literacy skills (Reyna, Hanham, & Meier, 2018).

Each teaching context is unique and varies between technology, pedagogy, and content, so teachers must be faced with making decisions that are in accordance with technological developments, pedagogy, subject matter, and classroom context. The diversity of responses implies

that a teacher must be an active agent and curriculum designer himself. The complex and unstructured nature of teaching with technology leads to the notion of teacher as designer, who is constantly engaged in an active, iterative, and problem-driven process of feedback from finding and creative problem solving (Kaplan, 2017).

In fact, many teachers are still not optimal in using technology as a medium for learning biology. Table 1 shows that there are still many teachers who have not used multimedia in biology learning.

**Table 1. Tables And Figures Should Be Valuable, Relevant, And Visually Attractive**

Category	Item 1 (%)	Item 2 (%)	Item 3 (%)
Always	23,64	81,82	9,09
Often	49,09	16,36	16,36
Seldom	25,45	0,00	65,45
Never	1,82	1,82	9,09
<b>Average (%)</b>	<b>64,84</b>	<b>92,72</b>	<b>41,81</b>

Description:

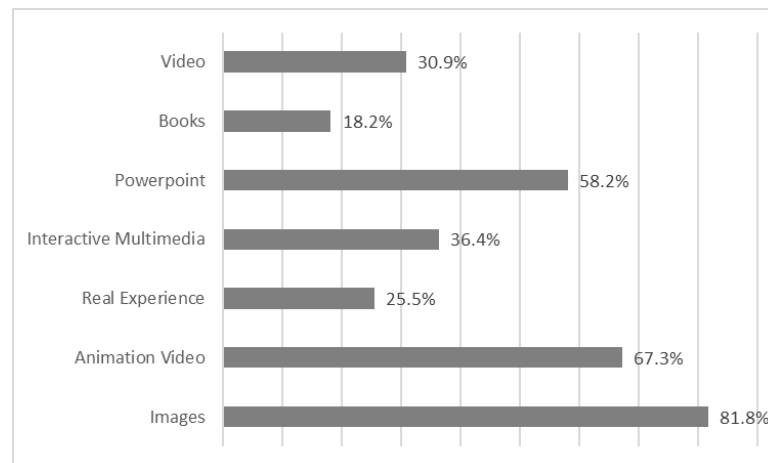
Item 1. Use of learning media in teaching biology

Item 2. The importance of learning media to teach abstract concepts

Item 3. The utilization of multimedia in teaching abstract concepts is discussed if necessary, as the investigation aim is discussed in the Introduction section.

Less than 50% of biology teachers used multimedia. The findings of this study indicate that 92.72% of teachers agree that learning media needs to be used to teach various abstract biological concepts. In addition to helping explain abstract material, the use of multimedia can also help students manage their cognitive load during the learning process (Kastaun et al., 2021).

Figure 3 illustrates the percentage of use of various learning media in biology learning. This data provides important insights into media usage trends and preferences by educators as well as their effectiveness in supporting biology learning.



**Figure 3. Learning Media iqan Biology Material**

Images are the most widely used learning medium. This suggests that simple visualizations, such as diagrams, microscopic photographs, and illustrations of biological processes, are the primary means of explaining biological concepts. Images have the ability to simplify complex

materials, such as anatomy, life cycles, or ecosystem interactions, making it easier for students to understand. Furthermore, as many as 67% of respondents also use animated videos. Animated videos are superior to static images because they can visualize concepts involving time sequences and movements, providing a more engaging and interactive learning experience. However, the excessive use of images and animations without a strong pedagogical context can be counter-productive.

Powerpoint has a high percentage as a learning medium that is often used. PowerPoint presentations allow for the delivery of material in a structured manner with a simple combination of text, images, and animations. Although effective in supporting teachers' explanations, these media are often still passive, where students only become recipients of information without much interaction with the material.

In contrast, 36.4% of respondents who used interactive multimedia showed a shift towards a more collaborative approach. With interactive multimedia, such as virtual simulations, digital quizzes, and online modules, students can engage directly, which enhances learners' conceptual understanding. Although 25.5% of respondents cited real experiences as a learning medium, such as laboratory practices or field trips, the use of these media was relatively limited. Hands-on experience is essential in biology learning because it provides students with the opportunity to observe and participate in the biological learning process firsthand. The use of books is only 18.2%, which indicates a significant shift from traditional to digital learning media. While books still have an important role as a verified and in-depth source of information, their use may be considered less appealing to modern students who are more familiar with visual and interactive media. The weakness of books in conveying dynamic information, such as biological processes, is one of the reasons why this medium is less in demand. The direction of textbook development in Indonesia is more towards an integrated model, based on experiments and a scientific attitude. The development of the book does not emphasize aspects of scientific argumentation (Aryanti, Juliyanto, Trisnowati, & Amirul, 2024).

Ideally, learning media should be used in an integrated manner, where images, animated videos, presentations, real experiences, and books complement each other to provide a holistic learning experience. Teachers also need to be trained to make the most of technology, ensuring that the media used is not only visually appealing but also enriches students' understanding.

The results of this study show that learning media plays a crucial role in the biology learning process. Learning media can help simplify complex biological concepts, improve understanding, and strengthen students' motivation to learn. However, this study also reveals that despite the awareness of the importance of learning media, the use of technology, especially interactive multimedia, is still relatively low among educators.

The perception of teachers and students shows that learning media, especially technology-based, can make it easier to understand abstract concepts such as genetics and microbiology. Visual media, such as images and animated videos, are the most frequently used tools because of their ability to present information in a simple and attractive way.

However, the use of traditional learning media, such as books, is relatively low compared to technology-based media. Interactive multimedia, however, has not been utilized to its full potential by most teachers, although its potential to increase student engagement is very high. One of the main obstacles in integrating technology-based learning media is the lack of adequate infrastructure and training for teachers.

Most educators rely on simpler media, such as PowerPoint presentations or images, due to limited access to technological devices or a lack of skills to develop and use interactive multimedia. In addition, the results of this study also highlight the gap in the awareness and ability of educators

to utilize more advanced learning media. Some teachers still tend to use traditional approaches due to a lack of time and resources to prepare technology-based materials.

The importance of the development of interactive multimedia and animated videos can be gradually integrated with the support of education policies. Further research is also needed to evaluate the impact of this learning media on student learning outcomes. With the right approach, learning media has great potential to transform biology learning into a more engaging, meaningful, and inclusive experience for all students. The result show classroom that promotes the presentation of information in visual formats such as images, diagrams, flowcharts and interactive simulations have increased the students HOT's skill (Feranie, Kaniawati, & Suhandi, 2022).

Learning with interactive multimedia can help students understand subject matter (Wiyono, Ismet, & Saparini, 2020). Interactive multimedia help students provide a better picture of concepts that are abstract and difficult to imagine. However, there may be materials that cannot be explained well using interactive multimedia. For example, in the concept of ecology, it is better to use real media.

Interactive multimedia is not only media that displays text and images. Interactive multimedia is a two-way medium that allows interactions between media and students (Pratomo, 2013). Interactive multimedia does not require complex and difficult programming languages to learn. Microsoft PowerPoint, which is widely used by teachers, can also be an alternative for creating interactive multimedia. Interactive multimedia developed from Microsoft PowerPoint was proven to increase student interest in learning. Various abstract concepts that exist in biological materials require the help of media to explain them. Technological advances should be used to design media that can help explain these abstract concepts (Nagmoti, 2017).

These findings are supported by those of (Prochazkova et al., 2019), who found that genetics is a difficult concept. Many students find this topic uninteresting and unrelated to future specializations. Some of the factors that are considered difficult in the field of genetics are genetic material, reproduction of genetic material, genetic changes and mutations, genetics in populations, and genetic engineering. The material is considered to have a high level of abstraction because the object cannot be seen directly, but requires assistance. A high level of abstraction often makes this material misunderstood by educators and students. Genetics is a field of biological science that is developing rapidly; therefore, in its delivery, appropriate technological developments are required.

This shows the need for a systematic training strategy and educational policy support to improve teachers' competence in utilizing technology. The lack of interactive multimedia utilization reflects the potential that has not been fully utilized in biology learning. With this media, students can be more actively involved in material exploration. Technology-based learning strategies also have the potential to reduce access gaps for schools that lack laboratory facilities, by providing similar learning experiences virtually.

Teachers need to have a deep understanding of the components of knowledge technology, pedagogy, and content. According to (Figg, C. & Jaipal, 2012; Koehler & Mishra, 2008; Koehler, Mishra, Akcaoglu, & Rosenberg, 2013) a teacher with pedagogical knowledge can understand how students build knowledge and acquire skills, develop thinking habits, and have positive dispositions towards learning. One of the uses of technology in learning can be seen in the use of learning media during teaching and learning activities.

Interactive multimedia is the use of multimedia and ICT, which allows interaction between media and students. Animations, interactive simulations, and video recordings were mentioned as benefits by students because they facilitated processing of information, provided different ways to present the information, allowed for a variety of response, navigation, and flexibility options, and allowed for self-evaluation of their progress (Ali, Abdul Talib, & Jamal, 2023). Indeed, the use of multimedia has attempted to present various forms of information in images, sounds, and videos.



However, this type of multimedia has not been able to provide interactions that can make the learning process more meaningful.

## CONCLUSION

The study has revealed that both teachers and students perceive biological materials as challenging due to their abstract nature. This complexity necessitates the use of educational media to aid in the learning process. Teachers and students agree that technology-based media can improve understanding of biological concepts and strengthen student engagement. While there is a significant reliance on media to convey biological concepts, the findings indicate that the potential of technology-based media, particularly interactive multimedia, has yet to be fully realized and optimally integrated into the curriculum. Teachers and students acknowledge the value of interactive media in enhancing understanding, yet report that its use is not widespread, pointing to an opportunity for educational development. With these steps, technology-based learning media can be optimized to create a more inclusive, engaging, and effective biology learning experience. Future efforts in educational reform should therefore focus on expanding access to and training in technology-based learning tools to maximize the benefits of interactive media in the study of biology.

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