



VIRTUAL REALITY AND AUGMENTED REALITY: REFORMULATING BIOLOGY LEARNING IN INDONESIA AFTER THE COVID-19 PANDEMIC

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Abstract

In Indonesia, online learning will still be carried out by teachers even during the post-COVID-19 pandemic. It will even become a trend for future learning, including in biology learning. The implementation of biology learning must be in accordance with the principles and nature of science learning, namely relying on hands-on activities. However, in the post-pandemic period this needs to be considered to be accommodated in future learning trends. This research approach is a qualitative approach. Data collection is secondary data. The data comes from the results of previous studies that are still relevant to the contents of this study. After the research data is collected, the researcher will then process the data, so that the research results can be found. The results of the study show that virtual reality and augmented reality are becoming increasingly urgent to use in biology lessons, especially for complements and/or substitutes for objects that are difficult to present in class. Merging real and virtual learning has a positive impact. Materials that were difficult to understand at first, due to space and time limitations and difficult to present in class, will become easier to understand. Therefore, the use of virtual reality and augmented reality media is very appropriate for use in biology learning in Indonesia after the COVID-19 pandemic.

Keywords: Virtual Reality; Augmented Reality; Biology Learning; Post COVID-19.

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1. Introduction

The COVID-19 pandemic has had a mega-dimensional impact. Significantly this pandemic has caused various problems for all levels of society, both religious, social, educational, and in all areas of human life. However, behind the disaster there are some lessons from this pandemic. One of the wisdom is felt in the field of education. In the world of education, all educators are able to carry out online learning. However, online learning in Indonesia is still experiencing problems, especially in biology learning. Educators still use applications that do not fully represent learning principles that require examples and problems contextually. As stated by Dewi, S. & Sari, N.F. (2022) that online biology learning at State High School 1 Bilah Hilir still uses Google Classroom, Zoom Meetings, and Google Meet. This makes conditions that are not optimal, especially in teacher and student communication, enthusiasm, student enthusiasm, and understanding of the material is still low, and time is not controlled. Furthermore, Santosa & S. (2020) stated that online learning in biology subjects at State Middle School 17 Kerinci experienced difficulties with the internet network, which made the learning process not run smoothly and not all students could enjoy it. Several obstacles show that online learning is not as easy as offline learning, especially network constraints which are often unstable, quotas run out quickly, and time cannot be optimal. Whereas in State Madrasah Aliyah 1 Metro it shows that social media can be used as an alternative in online biology learning, but it still does not maximize the ease of receiving material as offline

learning (Sa'diah et al., 2022). Some of the research results above show that the convenience of online learning offered by the Indonesian government is still not fully accepted by students. Complaints submitted by students included the many assignments given by educators, feeling bored and tired from staring at gadget screens continuously, and learning time was quite long, but the results obtained were not optimal. In Indonesia, online learning will still be carried out even during the post-COVID-19 pandemic. It will even become a trend for future learning, including in biology learning. The implementation of biology learning must be in accordance with the nature and principles of science learning, namely relying on hands-on activities. However, during this pandemic it is necessary to consider accommodation in future learning trends. Several solutions have been offered for learning after the COVID-19 pandemic. Marbun (2021) states that there are several learning designs in the post-COVID-19 era, including project-based learning, research-based learning, information technology-based learning, problem-based learning, learning using modules, blended learning, discovery learning, and remote learning. Suharyat, et. al. (2022) stated that post-pandemic science learning can be carried out online and offline. Online science learning is more effective if you adopt a mixed learning model (during and offline). Students are required to be able to master science skills and increase their understanding through online learning. In order to increase creativity and innovation in the use of technology, the teaching materials used must be accessible via the internet. Educators must also be able to master material and

technology in learning after the COVID-19 pandemic. However, not all subjects can be effectively carried out online. One of them is in biology subject. Basically, the implementation of biology learning must be in accordance with the nature and principles of science learning, namely relying on hands-on activities. Therefore, it is necessary to think about whether learning with hands-on activities can still be carried out in this all-online learning hegemony? How to accommodate learning with hands-on activities and objects of real and contextual biology problems into the trend of online learning modes? For this reason, a study is needed to find a solution so that online learning in biology can accommodate and remain based on the principles of learning biology as much as possible. Biological objects and problems are still used and must be attempted with various modifications, for example by modifying animated objects and biological problems, modifying recordings, and modifying imitations. In addition, it is also necessary to identify, organize, and use it optimally so that this modified form can produce effective learning. Based on the explanation above, the purpose of this study is to analyze the best new formulations of biology learning in Indonesia after the COVID-19 pandemic and in the future.

2. Method

This research approach is a qualitative approach. Data collection is secondary data. The data comes from the results of previous studies that are still relevant to the contents of this study. Data from previous studies were taken from

articles in national and international journals with a range from 2017 to 2022. After the research data was collected, the researchers then processed the data, so that the results of the research could be found.

3. Result and Discussion

The learning process involves three main elements, namely educators as senders of learning messages, students as message recipients, and material as the message itself. Conveying messages will be effective if using tools or intermediaries in the form of media. Currently the use of learning media is experiencing rapid progress. Various kinds and advantages have been shown by these learning media. One trend of the use of the media is the shift from two-dimensional media to three dimensions.

The development of digital technology in the 21st century that can make a very large contribution to biology learning is virtual reality and augmented reality technology. Virtual reality and augmented reality technologies have been widely used as learning media and learning materials for students and students. Virtual reality and augmented reality are applied to improve the quality of learning media. The application of Virtual reality and augmented reality in the world of education really helps students in understanding a material, procedure, assists students in understanding abstract concepts, is able to simulate phenomena and procedures, and provides experiences to students using sophisticated technology in learning without space and physics (Neuburger et al., 2018). Virtual reality and augmented reality are examples of cutting-edge technologies, which have

the potential to revolutionize the way we understand and interact with digital information that will make future displays of promise (Yin et al., 2022). Virtual reality and augmented reality will have a serious impact on the world of education, because this digital technology is able to unify one's perception of real space and virtual reality.

Virtual reality is a digital technology application that is capable of creating a simulation. Not only seeing objects through the screen, with virtual reality, students can surf and interact with a three-dimensional virtual world, which stimulates as many senses as possible, not only the sense of sight, but also hearing, taste/touch, and even smell. Virtual reality is a technology that allows users to interact with the environment in cyberspace, simulated by a computer, so that users are able to feel that they are already in that environment. Virtual reality has existed in education for more than half a century. However, widespread adoption has yet to occur. This is due to the limitations that exist both from the technology itself, as well as the costs required to implement it (Kavanagh, 2017; Boyles, B., 2017; Jumani, A.K., et. al., 2022). Early uses of virtual reality in science education focused on visualizing chemical reactions or learning about molecules by virtually assembling them. Virtual reality can enhance distance learning by enabling easier and more natural class discussions in remote learning settings. Students and teachers can be in the same virtual space, they can ask questions if concepts are not clear, teachers can use discussion techniques to foster critical thinking (Boyles, B., 2017). Virtual reality describes an environment created

by a computer system that simulates real world situations and events (Fernandez, 2017). In the field of biology, simulation can be described through interactions between ecosystem components, as well as energy flows and material cycles of an ecosystem. In addition, simulation can also be described in the movement of blood cells, gamete cell movements, molecular movements between cells, ionic movements between cell organelles, or movements between organs. This simulation can be based on facts from research results, theory, or the imagination of simulator experts. Virtual reality provides an opportunity to increase student engagement. Students are able to carry out learning with direct, interactive, immersive experiences, and provide new experiences that they have never encountered before. Virtual reality is able to create virtual simulations to Mars, the ocean floor, and so on so that it triggers student interest in learning and trains student curiosity. Virtual reality also provides an opportunity to carry out constructive learning, that is, it allows students to construct their own knowledge from meaningful experiences. The affordability of virtual reality is able to give students the ability to visually construct objects that can be manipulated to represent knowledge. As such, virtual reality has great potential to enhance the educational landscape by making immersive learning environments adaptable, students actively engaged, and self-regulating. Virtual reality is also superior in providing opportunities to increase empathy and the ability to visualize difficult models. For example, when students are given virtual reality experiences as elderly people, their empathy towards the older generation

increases significantly (Au & Lee, 2017). From the perspective of educators, educators think that virtual reality is interesting, encourages students to be active, suitable for students with schematic and visual thinking styles, provides an overview for students about subjects, makes students easier to learn material, and requires concentration (Serin, 2020). In various countries it has been shown that learning biology using virtual reality has had a positive impact. Christopoulos et al. (2022) conducted research on the use of virtual reality in learning cell biology material showing that virtual reality can improve learning outcomes and student learning experiences. However, apart from technology, the role of educators is very important, namely they must be able to manage situations and experiences for students, so that students have active involvement in building their own knowledge. Therefore, educators must also improve their skills in technology and their curiosity. Bennett & Saunders (2019) also stated that the use of virtual reality in learning cell biology material can increase student interest in learning, increase student understanding, and foster new student perspectives. Morimoto & Ponton (2021) also stated that the application of virtual reality has the potential to be one of the most effective tools in overcoming distance and isolation while maintaining the adequacy of the learning potential of biology, medicine, and all fields of education. Virtual reality is also capable of learning to operate microscopes through microscope simulations (Zhou et al., 2020). During online learning, of course, students find it very difficult to learn in the laboratory, one of which is in basic laboratory learning, namely

how to operate a microscope. Through this virtual reality students are assisted in recognizing the structure of a microscope and understanding the operational use of a microscope. Students can perform skills by simulating operations using an interactive microscope. Therefore in the future virtual reality will be a successful learning platform in open learning spaces. Research that has been conducted in Greece also shows that through virtual reality students' understanding of the use of light microscopes increases. Videos and virtual labs are often incorporated into the learning process as independent learning tools that help students gain scientific knowledge and skills in the laboratory with confidence (Paxinou, E. et. al, 2019). Choi & Kim (2020) demonstrated the application of virtual reality programs in biology classes, the results show that virtual reality can reflect manipulation, multisensory, and interaction in learning. Virtual reality also improves students' thinking skills both in spatial, abstract and reflective thinking. Virtual reality also has a positive effect on the cognitive and affective domains. Based on several previous studies on the use of virtual reality in biology learning, virtual reality can be used as an alternative to new formulations in biology learning in Indonesia after the COVID-19 pandemic.

Along with the development of digital technology, not only is virtual reality capable of making learning more effective, but the use of augmented reality is also increasingly intensive in the world of education and learning. In biology subjects, the use of augmented reality is also very intensive and massive, as a support for the quality of

teaching and learning media. Unlike virtual reality, augmented reality is an application that uses 4D technology and transforms virtual environments into real life (Sontay & Karamustafaoğlu, 2021). Jang et al. (2021) also stated that augmented reality is able to complement virtual reality, not completely replace it. Augmented reality makes it possible for users to be able to see the real world through virtual objects that have been combined with the real world, so that through augmented reality can make learning active, constructivist and authentic.

Merging the virtual world with the real world through augmented reality is intended to produce clearer and more interesting information that departs from the system to real objects. In its development, augmented reality is able to create interactions between the virtual world and the real world. With augmented reality, all information can be added. This information can be displayed as interactive and real information, as well as real time. Augmented reality can be used to visualize abstract concepts for the understanding and structure of an object model. Augmented reality works by overlaying 3D digital image files onto the real world. The background will appear through the mobile device's camera app. After the augmented reality device is placed in the classroom, through the device students can view digital images at all angles (Pacheco-Guffrey, 2022). From the description above, it can be explained that there are three characteristics of the concept of augmented reality technology, namely (1) being able to combine the virtual world and the real world, (2) being able to provide interactive and real time information, and (3) being able to

provide objects in three dimensional shape.

As explained above, that several augmented reality applications have been designed to provide more detailed information to users from real objects. The advantage of augmented reality is that it can be applied using smartphones or other vehicles that are familiar to students. In addition, the visual appearance is also attractive, which can display three-dimensional objects that seem to exist in the real environment. This advantage is really needed to be able to help students understand biological material, which is abstract, complicated, or is in the body systems of living things. So, augmented reality is a way to explore three-dimensional objects and data. Augmented reality is the concept of a combination of virtual reality and world reality. Virtual objects in two dimensions and/or three dimensions merge with the real world, so they look real. Augmented reality aims to simplify things for users by bringing virtual information into the user's environment (Usada, 2018). Gamboa-Ramos et al. (2021) also stated that currently augmented reality has been carried out by teachers and students in distance and/or face-to-face learning through dictactic learning, self-instruction, and research promotion. Through learning with smartphone media based on augmented reality applications, it is able to strengthen science and technology learning so as to increase student understanding and enhance student learning. Progress and the adoption of innovative learning methods indicate that society is open to new technologies and new ideas, one of which is the use of augmented reality in learning. Augmented reality has been successfully applied in learning science,

technology, engineering and mathematics. Learning becomes practical and creative, and improves kinesthetic abilities (Iqbal et al., 2022; Petrov & Atanasova, 2020). In various countries, even though before the COVID-19 pandemic many used augmented reality in learning, in Indonesia the use of augmented reality in learning is still minimal, for various reasons. Even during a pandemic, even though learning is carried out online, the use of augmented reality is still rare. Most of online learning only uses WhatsApp, Zoom, Google Classroom, and LMS applications. However, along with technological developments, the use of augmented reality in learning in Indonesia has begun to increase, especially in learning science, including biology. As stated by Aripin, I., & Suryaningsih, Y. (2019) that augmented reality media is considered suitable for facilitating biology learning, because in biology learning many concepts are abstract which of course it will be easier if presented in three dimensions so that it is more concrete.

The expected impact is to reduce misconceptions in students. Augmented reality has advantages including being able to present abstract concepts more concretely, being able to increase student understanding, and being able to make learning more meaningful and motivating students. Tritono, A. (2021) also stated that so far in learning biology at school there are still many problems, especially with equipment in the laboratory such as microscopes or other equipment that is inadequate. This causes difficulties in presenting the material. To overcome this can be done with augmented reality. Augmented reality makes it easier for teachers to convey leaf and stem tissue material, so

that students' understanding increases. In addition, augmented reality can also improve student academic achievement when compared to traditional learning (Ozdemir et al., 2018). Augmented reality is a cost-effective technology, content is more interesting than using paper, therefore it is necessary to expand its use to all levels of education (Fridhi, A. & Bali, N., 2021). Augmented reality is also able to encourage students to think critically and creatively to enhance their experience and understanding. In the last decade, augmented reality has begun to be used in education in several subjects including medicine, biology, chemistry, physics, mathematics, geography, astronomy and history. The use of augmented reality technology has been growing all over the world, but its development has not been widespread in Indonesia, including in biology learning. The fact still shows that augmented reality has not been optimally implemented by schools, so there needs to be wider outreach and training regarding the need for various augmented reality-based sciences (Gestiardi et al., 2022). In addition, many students in Indonesia do not know about augmented reality, as stated by Oktavia (2022) that at High School 1 Pante Ceureumen West Aceh as many as 30 students do not know about augmented reality, and the school has not used augmented reality media, including at Biology learning. Based on the description above, it is necessary to have a new formulation of biology learning in the post-covid 19 era, namely by using augmented reality media. Some biology learning in Indonesia that uses augmented reality shows that the use of media with augmented reality in biology learning

has been able to assist in facilitating the biology learning process. Learning becomes more interesting, easy for students to understand, increases student motivation, and is able to present a good visual representation of biology learning material. According to Aripin, I., & Suryaningsih, Y. (2019) presenting three-dimensional visualization through augmented reality technology can reduce misconceptions in students.

Pambudi, S., A., N. & Rahmi, A., N. (2022) also stated that learning with augmented reality technology in learning animal cells and plant cells can help the biology learning process at State High School 1 Dlingo, Yogyakarta. Learning applications with augmented reality on excretory system material in humans with smartphones can improve students' understanding of Stat Middle School 1 Sukoharjo, Pringsewu (Aprilinda et al., 2020). Technology is a much-needed approach in various fields, including education. Augmented reality innovations can continue to be developed given the increasingly rapid development of technology (Amalia, 2022). Therefore, augmented reality can be used as technology in the 21st century that is able to answer future challenges and can improve students' understanding and skills. The use of augmented reality as a medium for learning science has also been proven to improve student learning outcomes. Therefore, in order to make the use of augmented reality more effective, efforts are needed to develop the use of augmented reality in biology subject matter which requires visualization of objects, for example in material on the circulatory system and respiratory system (Juwita et al., 2021). The results of implementing biology

learning with augmented reality media at State High School I Kadipaten, Majalengka Regency also show results that are classified as effective and can increase student learning achievement by up to 76% (Aripin & Suryaningsih, 2019b). In a study by Sylvia et al. (2020), augmented reality also has an effect on higher-order thinking skills and is very useful for the continuity of the learning process in high schools in Sukabumi. The application of Assemblr EDU media based on augmented reality can also improve student learning outcomes at Stat Middle School 3 Makassar (Lino Padang et al., 2022). Augmented reality can be said to be able to provide an effective learning experience, because augmented reality is able to generate three-dimensional images. Through three-dimensional images it is easy for students to accept material and students will be interested in learning, even in online learning. The use of augmented reality in learning also has the opportunity to increase the interaction between teachers and students (Nurhasanah et al., 2021). In addition, the use of augmented reality applications in learning can also improve students' mastery of concepts and creative thinking skills (Wulandari et al., 2020). Based on the explanation above, it shows that virtual reality and augmented reality are two things that are almost the same. Augmented reality can seem like virtual reality, and vice versa. Virtual reality creates habitable artificial environments, whereas augmented reality simulates artificial objects in real environments. Virtual reality and augmented reality are the next generation display platforms that can interact between humans and digital in a more profound way (Xiong et al., 2021). Virtual reality and augmented reality are

becoming increasingly urgent to use as a substitute or complement to objects that are very difficult to present in class. Through the combination of real and virtual learning, it is hoped that materials that were difficult to understand due to examples that were difficult to present due to space and time limitations will become media that can be accepted by students. Utilization of virtual reality and augmented reality media is very appropriate for use in classroom learning that requires the presence of an example in class. For example, in classifying animals based on the type of food, it will be very difficult to do in the traditional model, because it is very difficult to present examples of real animals in class. Instead, it becomes easier to present sample images or recordings. Muñoz et al. (2022) also stated that virtual reality and augmented reality are rapidly positioning themselves in the growing medical and ophthalmology sector. The use of virtual reality and augmented reality applications in ophthalmology training can increase students' self-confidence. Until the end of the 2 decades of the 21st century, there are still many biological phenomena whose process explanations still use assumptions or theories, because they involve very small object sizes and/or take place in a very short or very long time. Visualization and/or animation of biological objects or processes which are very difficult, in order to increase students' understanding/literacy about biology, it is very urgent to be assisted by this application of digital virtual reality and augmented reality technology. Education in the 21st century is directed at results in which students will be able to apply technology, both through digital

literacy, creative thinking, critical thinking, and having very good interpersonal and social skills. Therefore, the curriculum in biology education must also be able to accommodate learning materials or activities that can equip and train 21st century skills. The 21st century skills in question are creative, critical thinking skills, having a scientific attitude and other relevant affective values. In addition to students, biology teachers must also be ready and able to design learning activities that have the potential to develop 21st century skills for their students. Thus, there are rapid advances in communication and technology, virtual reality and augmented reality are future generation display platforms that can interact between humans and digital in more depth, very suitable for use in biology learning.

4. Conclusion

Until the end of the 2 decades of the 21st century, there are still many biological phenomena whose process explanations still use assumptions or theories, because they involve very small object sizes and/or take place in a very short or very long time. Visualization and/or animation of biological objects or processes which are very difficult, in order to increase students' understanding/literacy about biology, is very urgently assisted by this digital virtual reality and augmented reality technology application. Virtual reality and augmented reality are used as a substitute or complement to objects that are very difficult to present in class. Thus, there are rapid advances in communication and technology, virtual reality and augmented reality are future generation display platforms that can

interact between humans and digital in more depth, very suitable for use in

biology learning in Indonesia after the COVID-19 pandemic.

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