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Enhancing Learning Motivation and Student Engagement through Virtual Reality in Virus Topic Learning

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ABSTRACT

The integration of innovative technologies into biology education has become increasingly important for enhancing students' motivation and engagement, particularly when studying abstract topics such as viruses. This study aimed to examine students' responses to the use of Virtual Reality *(VR) in learning about viruses in biology. The study employed a Classroom Action Research (CAR) design based on the model of Kemmis and McTaggart and was conducted in two cycles. Data were collected through student questionnaires. The results showed that the average response in the first cycle reached 68.73%, which was categorized as sufficient. In the second cycle, involving 35 students, the average percentage increased to 81.79%, indicating a higher level of positive responses. More than 80% of students reported increased motivation to learn and greater active participation in discussions, group work, and interactions with learning materials through VR simulations. These findings suggest that VR-supported learning can enhance students' motivation and engagement in understanding complex biological concepts.*

INTRODUCTION

In the 5.0 era, society aims to improve the quality of life by utilising technology's productive potential across various sectors, including education. Educators are expected to design innovations and learning strategies that can increase effectiveness in the context of the 5.0 era (Slater & Sanchez-Vives, 2016). Revealed that the development of the society 5.0 era is in line with technological advances. In Japan, this concept, which puts people first and is supported by technology, emerged in response to the impact of the Industrial Revolution 4.0, which risks reducing the role of humans (Radianti et al., 2020).

The role of technology is significant in driving transformation across various areas

of human life, enriching knowledge, and improving skills in carrying out activities. One of the technologies that has significantly contributed to this change is augmented reality (AR) (Aditama, 2019). In a study by Meslilesi (2017), the results of user acceptance testing conducted through pre- and post-tests showed that students who used biology printed books increased their scores by 20.06%. Meanwhile, among students who used augmented reality applications to study viruses, the increase in scores from pre-test to post-test was 25.31%, indicating that AR can be applied effectively.

In the digital era, Ignatius Slamet Riyadi High School faces challenges in providing innovative and contextually relevant learning that aligns with the characteristics of Generation Z. Students today tend to prefer visual and interactive learning experiences and quickly become bored with conventional lecture-based methods. This condition is also evident in biology learning, which is often perceived as difficult because it requires an understanding of abstract concepts, microscopic processes, and the relationships among biological systems that cannot always be directly observed. In addition, the limitations of laboratory facilities and constraints on field observation make it difficult for students to engage in meaningful learning. Virtual Reality (VR) is among the innovative solutions to improve the quality of Biology learning (Sari & Setiawan, 2018).

The main challenges in biology learning involve time limitations and variations in students' academic abilities (Adinugraha, 2023). Student activity is not only reflected in physical actions, such as answering questions or participating in discussions, but also in psychological aspects, such as interest and drive to learn. It includes activities such as asking questions, expressing opinions, and seeking information to solve problems.

This research raises concerns about low student activity, as evidenced by the rarity of their responses to teachers' questions and the lack of classroom interaction. Students' activity can increase if they are motivated to learn. The learning process will become more lively if students have an urge to learn, which can be triggered by the presence of teachers in the classroom. The presence of teachers in the classroom can increase students' motivation, making them more active in learning.

Virtual Reality (VR) is a technology that allows users to interact with computer-generated environments that simulate real-world experiences through visual, auditory, and motion-based interactions (Burdea & Coiffet, 2003). The role of computers in this case is to simulate real objects by creating three-dimensional (3-D) spaces so that users

feel an experience as if they were directly involved (Slater & Sanchez-Vives, 2016; Sherman & Craig, 2019).

Innovative learning media, such as virtual reality, have the potential to increase students' interest and understanding of the material, as shown in trials using YouTube VR. It suggests that integrating VR technology in learning could address challenges in engaging Generation Z learners. The difference from the previous study is that the trial was carried out without the material or the pocketbook. In contrast, in this study, the material used was related to the virus and included a pocket book. Another study by Ibáñez & Delgado-Kloos (2018) revealed that 77.6% of teachers responded positively to the use of bioplastic preservation media, and 98.4% of students responded positively to invertebrate preservation media using bioplastic techniques. These two studies share the aim of analyzing teachers' and students' responses to the use of learning media.

RESEARCH METHOD

Study Design

This research uses the Classroom Action Research (CAR) approach, a method teachers can apply to improve the learning process and achieve set goals. The implementation of CAR is closely aligned with teachers' roles as educators, supervisors, trainers, and evaluators in assessing student learning outcomes (Kemmis & McTaggart, 1988).

The implementation of CAR is carried out through two cycles, each consisting of planning, action implementation, observation, and reflection. In the first cycle, the researcher designed Biology learning using Virtual Reality media to improve students' understanding of concepts. This study uses a quantitative descriptive approach to analyze students' responses to the use of VR learning media equipped with pocket books, conducted in two cycles (Sugiyono, 2019).

Data Collection

The data collection technique used in this study is through questionnaires. The lesson plan is outlined in lesson plans, evaluation tools, and observation sheets. The action was carried out by providing an immersive VR learning experience to students in grades X B and X C. After the learning process was completed, a questionnaire was administered to the respondents (students) via a Google Form. During the process, researchers and teachers observed student involvement, learning motivation, and formative test results (Fraenkel et al., 2012; Black & Wiliam, 2009).

Data Analysis

Data analysis uses descriptive statistics to provide an overview of the research success rate. The percentage of

student responses is calculated using the formula.

$$N = \frac{S}{S\ Maks}\ X\ 100$$

Information:

N = Learning Implementation Value

S = Learning Achievement Score

S Maks = Maximum Learning Score

The responses of teachers to the applied learning media were collected and categorized. Similarly, students' responses to the same learning media were also recorded. The categories of both teacher and student responses are presented in **Table 1.**

RESULTS AND DISCUSSION

Data were obtained through a Likert-scale questionnaire that measured students' responses to the application of Virtual Reality (VR) in Biology learning. The analysis was carried out in two cycles, namely cycle I and cycle II, to examine differences in student motivation and activity, as shown in **Table 2**.

The results of cycle I showed that students' responses to learning with VR remained in the "Sufficient" category, with an average of 68.73%, indicating low participation (67.55%) and attraction (67.74%). This finding aligns with Reen et al. (2021), who stated that new media use requires adaptation time before fostering learning enthusiasm. In this cycle, VR-based learning media obtained a score of 68.7%, categorized as "Poor," as VR had not been fully implemented and conventional methods were still used. In cycle II, after full VR implementation, the average score increased to 81.7% ("Good" category), indicating that VR learning media are suitable for classroom application.

Based on these findings, the second cycle was conducted with improved learning strategies. During the planning stage, Teachers organized smaller groups to allow students to be more active in using VR. The action emphasized student interaction and concept reinforcement through post-VR discussions. Observations, participation, responses, and test improvements.

Table 1. Student response percentage scale

Value	Predicate
95% - 100%	Excellent
75% - 95%	Good
25% - 75%	Sufficient
0% - 25%	Less

Table 2. Differences in motivation increase from Cycle I to Cycle II

Indicators	Cycle I (%)	Cycle II (%)	Increased
Material	70.95	82.30	+11.35
Participation	67.55	80.15	+12.60
Enthusiasm	68.69	83.45	+14.76
Attraction	67.74	81.25	+13.51
Average	68.73	81.79	**+13.06**

Reflection results showed significant gains in students' concept understanding. Students also demonstrated increased learning motivation, with most meeting the established performance indicators. Based on these outcomes, the research was concluded in Cycle II.

In cycle II, after strategy improvements (e.g., small-group learning, discussion after VR exploration, and technical assistance), the average response increased to 81.79%, placing it in the "Good" category. The highest increase was seen in the indicator of enthusiasm for learning at 14.76%. It supports the findings of Majewska et al. (2023) that VR media can increase students' intrinsic motivation through enjoyable immersive learning experiences.

Cycle I

The bar chart **Figure 1** illustrates students' responses to various aspects or indicators in conventional learning in cycle I. The material received a score of 70.95%, indicating it was quite easy to understand. The participation indicator was only 67.55%, which shows that although the material provided was quite good, student participation was lacking. The indicator of enthusiasm for learning is 68.69%, suggesting a less enthusiastic response to conventional methods.

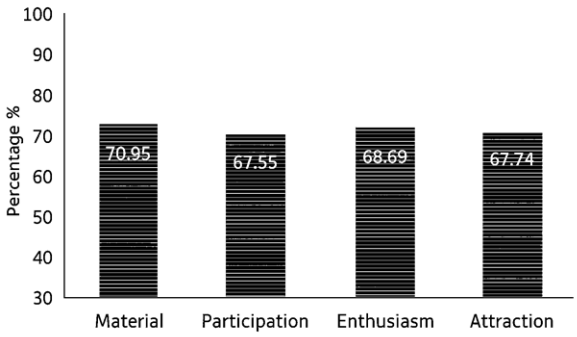

Figure 1. Results of cycle I

The student attraction indicator of 67.74%, reflecting the lack of student interest in the application of conventional methods, is also presented in **Figure 2A** for cycle one activities. The study shows that applying VR in Biology learning at Ignatius Slamet Riyadi High School improves students' understanding, motivation, and engagement. This finding aligns with Elme et al. (2022), who reported that immersive VR in STEM education increases interest in learning and participation.

Teachers and researchers reflect on the results of the action by evaluating the activities carried out in the first cycle, then plan improvements to be implemented in the next cycle. If the results of cycle I do not meet the set success criteria, improvements will be made in the next cycle. The improvement steps are based on the results of the evaluation and feedback from cycle one, and are supported by the VR handbook. The cycle II activities are shown in **Figure 2B.**

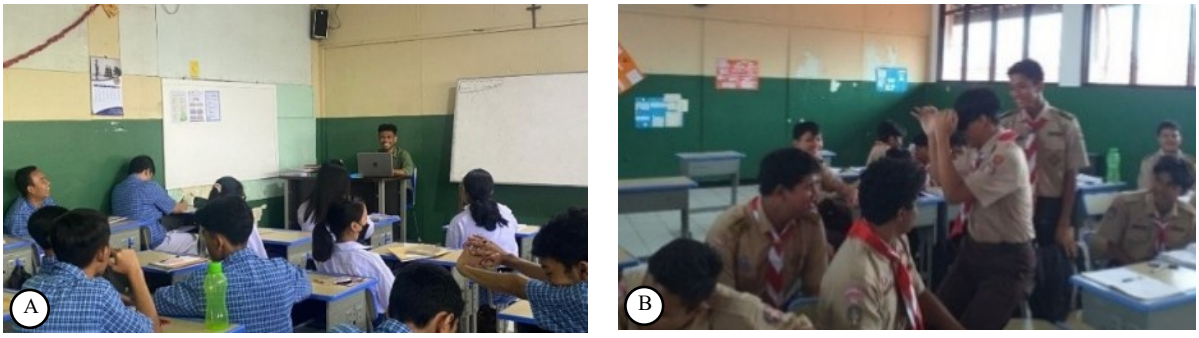

Figure 2. Student activities during learning. A. Cycle I; B. Cycle II

Cycle II

The main objective of cycle II is to increase further students' activity and motivation to learn by ensuring that VR technology is used effectively. In this cycle, the researcher and the teacher made several changes, including the VR method used, the duration of use, and the type of YouTube link used, to provide a better learning experience during the implementation of the second cycle. The results are presented as a bar chart in **Figure 3.**

An indicator of material understanding showed that more than 83.9% of students felt VR made it easier to grasp complex concepts, as the visualizations were more precise and concrete. Regarding learning attractiveness, 85.36% of students reported being more interested and engaged due to the fun and novel experience compared to conventional methods. For the pleasant learning experience indicator, 82.8% of students stated they were happier and more interested in learning with VR, making lessons more engaging and less monotonous.

The application of Virtual Reality (VR) in learning can enhance student motivation and participation. Based on the learning motivation indicators (questions 1–4), VR provides a more immersive and interactive experience, which increases students' enthusiasm and interest in the presented material.

This immersive experience stimulates higher curiosity, as students can interact directly with objects or three-dimensional simulations—something that is difficult to achieve with conventional learning methods. Consequently, VR not only supports understanding but also encourages active learning and deeper engagement with the subject matter.

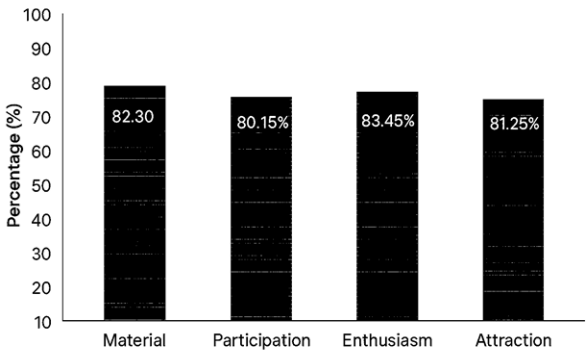

Figure 3. Results of cycle II

Based on the results of a study using student questionnaires, the use of VR in learning reached more than 80.00% across the five indicators tested. First, on the learning motivation indicator, more than 80% of students reported feeling more motivated and excited about the lesson after using VR. The immersive and engaging learning experience makes them more interested in exploring the material being taught. Second, in the student activity indicator, more than 80% of students became more active in class discussions, working together on group assignments, and interacting with learning materials through VR simulations.

Virtual reality can also be associated with a more contextual approach to teaching biology topics related to local wisdom (Anatasya & Putra, 2024). Indigenous knowledge related to biodiversity has been scientifically documented in various studies. Several researchers have reported the use of plants and animals in traditional ceremonies and rituals, such as *ubarampe* in the *wiwitan* tradition (Adinugraha, 2024), *kepungan* (Adinugraha, Zubaidah, et al., 2024), and *manafo* rituals in the Nias region (Adinugraha, Gulo, et al., 2024).

In addition, traditional ecological knowledge is reflected in the preparation of traditional foods that utilize plant resources, including coconut sugar in the Somongari Javanese community (Adinugraha et al., 2025), *pelleng* from the Batak Pakpak culture (Sitinjak et al., 2025), *bubbor paddas* from the Sambas Malay community (Adinugraha, Grace, et al., 2024), and *dekke na niarsik* from the Batak Toba tradition (Marpaung et al., 2025). The relationship between plant utilization and environmental conservation, such as protecting water springs, is also closely linked to biodiversity education (Sabasti et al., 2024).

CONCLUSION

This study concludes that the use of Virtual Reality (VR) in biology learning improved students' motivation and engagement. The results showed that the average student response increased from 68.73% in Cycle I (sufficient category) to 81.79% in Cycle II (good category) after improvements in learning strategies and the full implementation of VR. Questionnaire results also indicated that more than 80% of students reported higher learning motivation and more active participation in classroom discussions, group activities, and interactions with learning materials through VR simulations. These findings suggest that VR-based learning can create a more engaging and interactive learning environment and support students' understanding of complex biological concepts.

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