

The Application of 3D Virtual Reality (VR)-Based Learning Media to Improve Cognitive Learning Outcomes in Grade 5 IPAS at SDN 2 Dukuhwaluh

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ABSTRACT

In the era of the 4.0 industrial revolution, teachers are not only tasked with conveying information, but also with helping students by utilizing technology. One of the problems in elementary school learning is the lack of student interest in the subject matter, especially when the learning media used is monotonous. This study aims to improve the cognitive learning outcomes of fifth-grade students at SDN 2 Dukuhwaluh in the subject of Integrated Science and Technology (IPAS) through the application of three-dimensional learning media based on Virtual Reality (VR) with the assistance of a VR Box. This research is a Classroom Action Research (CAR) consisting of three cycles. Each cycle includes four stages: planning (plan), implementation of actions (act), observation (observe), and reflection (reflect). Data collection methods include tests, observations, and documentation. Tests are used to gather data on students' cognitive learning outcomes, while observations are used to monitor students' learning activities during the learning process. Additionally, documentation is used to support visual data of learning activities. The research results indicate that the application of VR media can improve students' learning outcomes. The average student score increased from 60.6 in Cycle I to 77 in Cycle II, and reached 84.5 in Cycle III. The study concluded that the application of three-dimensional learning media based on Virtual Reality (VR) can improve the cognitive learning outcomes of fifth-grade students at SDN 2 Dukuhwaluh.

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1. INTRODUCTION

The rapid development of information and communication technology in the era of the Fourth Industrial Revolution has transformed many aspects of society, including education. Education in the 21st century demands changes in the learning process. The primary focus is on the students, not the teachers. Teachers must now be able to engage students in active, creative, and enjoyable learning experiences, in addition to imparting knowledge (Putri et al., 2025). Some disciplines, particularly Natural Sciences and Social Sciences (IPAS), which are more abstract and conceptual, may not appeal to students. This is one of the main challenges in introducing 21st-century learning in elementary schools.

One source of low learning interest is the use of traditional, static, and non-contextual learning materials. However, the use of appropriate learning resources can enhance students' memory of the material studied, facilitate concept understanding, and increase student engagement in the learning process (Aprijal et al., 2020).

Therefore, the utilization of digital technology capable of addressing current educational challenges is one way to innovate in the selection of learning materials (Aisyah et al., 2025).

Virtual reality (VR) technology is one of the latest forms of media currently developing in the field of education. Thanks to virtual reality (VR), students can now visualize and interact with scientific concepts, which was previously impossible with traditional media (Siahaya et al., 2024). Considering that elementary school students are still in the concrete operational stage of learning according to Piaget's cognitive development theory, this is very important for their education.

This study aims to identify the challenges in understanding the cognitive learning outcomes of fifth-grade students at SDN 2 Dukuhwaluh in science lessons. This study aims to determine whether the use of three-dimensional virtual reality-based teaching materials can improve students' cognitive learning outcomes. In addition to helping students catch up with Pancasila teachers who are able to think critically, creatively, and technologically, this study is expected to help develop more creative and flexible learning strategies in line with the needs of students in the digital age.

1.1. Research Methodology

This study uses a Classroom Action Research (CAR) approach, which aims to improve and enhance the quality of learning directly in the classroom (Aziz et al., 2023). CAR was chosen because it aligns with the research objective of improving students' cognitive learning outcomes through the application of Virtual Reality (VR)-based learning media. The CAR model used is based on Kemmis and McTaggart's design, which consists of four stages: planning, acting, observing, and reflecting (Maliasih et al., 2017).

The research was conducted in three cycles, each covering one IPAS learning session. Each cycle was conducted continuously, with reflections from the previous cycle used to refine the planning and implementation in the next cycle.

1.2. Research Media and Instruments

The learning media used in this study was three-dimensional Virtual Reality (VR) media with the assistance of a VR Box and IPAS learning content tailored to fifth-grade material. The content presented covered topics such as the environment, ecosystems, and natural phenomena. Students learned by exploring virtual objects displayed through smartphones connected to the VR Box.

The instruments used in this study consisted of:

- Cognitive tests (pre-test and post-test) to measure improvements in student learning outcomes.
- Student activity observation sheets to record student engagement and responses during the learning process.
- Documentation in the form of photos, videos, and field notes used as supporting data.

1.3. Data Analysis

Cognitive test results were analyzed using descriptive quantitative analysis techniques, calculating the average score for each cycle. Improvements in learning outcomes were analyzed based on comparisons of scores between cycles. Observation data were analyzed using descriptive qualitative analysis to describe student activities and engagement during the learning process. Success criteria were determined based on improvements in class average scores and the achievement of the minimum competency standards set by the school.

2. APPLICATION OF VIRTUAL REALITY (VR) – BASED LEARNING MEDIA

Outcomes analyzed based on the average test scores in each cycle. The results are as follows:



Figure 1. Cognitive Learning Outcomes Diagram

- a. Cycle I: After learning using VR media for the first time, the average score of students reached 60.6. Most students still seemed to have difficulty understanding the material optimally because they were still adapting to the use of new technology. However, the enthusiasm of students began to increase.
- b. Cycle II: In the second cycle, the average score increased to 77. Students had become accustomed to using the VR Box, leading to improved interaction with the learning material. Discussions among students also became more active, and most students had achieved the Minimum Competency Criteria (MCC).
- c. Cycle III: The average score of students increased again to 84.5, and almost all students achieved the MCC. Student learning activities also showed a significant increase, both individually and in groups. Students were more active in asking questions, answering teachers' questions, and explaining the material they had understood from the 3D display.

These findings indicate a trend toward improved cognitive learning outcomes for students in several subjects, suggesting that the use of VR-based learning resources enhances students' understanding of IPAS concepts. Previous research has shown that integrating immersive technologies, such as virtual reality (VR), into the classroom can enhance students' attention, engagement, and understanding of abstract concepts.

In the context of IPAS education, three-dimensional representations help students understand complex concepts and processes that are difficult to explain succinctly, such as biological structures, environmental changes, and interactions between various living organisms within an ecosystem.

Additionally, the emotional and sensory engagement generated through VR-based learning experiences provides multisensory stimulation that strengthens students' memory and understanding. This is supported by constructivist learning theory, which emphasizes the importance of hands-on learning (learning by doing) and contextual learning.

Furthermore, 21st-century skills such as problem-solving, collaboration, and critical thinking can be developed through VR-based instruction. Students who use interactive media are more likely to actively investigate, debate, and consider their goals independently.

These findings indicate that the use of three-dimensional virtual reality-based learning materials significantly improves cognitive learning outcomes and makes the learning environment in fifth-grade classrooms more engaging, captivating, and enjoyable.

3. CONCLUSIONS

Based on this study, the use of three-dimensional virtual reality (VR) media significantly improved the cognitive learning outcomes of fifth-grade science students at SDN 2 Dukuhwaluh. The average student score increased from 60.6 in Cycle I to 77 in Cycle II and 84.5 in Cycle III. This demonstrates how immersive media, such as virtual reality, can enhance students' understanding of abstract concepts by providing realistic and engaging experiences. In addition to their academic achievements, students showed increased participation, engagement, and interest in class.

By fostering critical thinking, digital literacy, and active learning, virtual reality-based learning meets the expectations of 21st-century education. As a result, virtual reality media presents a viable alternative to conventional training. While schools must facilitate its implementation through infrastructure and training, teachers are urged to utilize this technology to enhance learning opportunities. Its broader impact on the affective and psychomotor domains may be explored in future research.

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