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THE EFFECTIVENESS OF CONCRETE MEDIA ASSISTED BY VIRTUAL DEMONSTRATION IN LEARNING IPA CLASS IV ELEMENTARY SCHOOL

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A B S T R A C T

This study examines the effectiveness of using concrete media assisted by *virtual demonstration* in learning Natural Sciences (IPA) in grade IV elementary school students. The background of this research is the need for learning strategies that can bridge the cognitive characteristics of concrete operational-age students with abstract science concepts. The research design used was a *one-group pretest-posttest design* with a quantitative approach. The research sample comprised 16 fourth-grade students of SD Negeri 1 Malangsuko who participated in learning using concrete media assisted by *virtual demonstration*. The research instrument, a learning outcome test, was given before and after treatment. The paired sample t-test analysis showed a significant increase in student learning outcomes, with the average value increasing from 50.00 to 68.75 ($p < 0.05$). This finding shows that integrating concrete media and virtual demonstration creates a multimodal and interactive learning environment and effectively improves the understanding of science concepts. This research recommends using the media combination as an alternative strategy aligned with 21st-century learning principles and the Merdeka Curriculum.

INTRODUCTION

Science learning in elementary schools is an essential foundation for building students' science literacy. However, many teachers experience obstacles in delivering

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science materials in practice due to limited media and a lack of practical facilities. According to Piaget's cognitive development theory, abstract science materials are often difficult for students to understand, especially at the elementary school level, whose thinking ability is still at the concrete operational stage (Santrock, 2021).

This condition demands innovative and adaptive learning strategies. Concrete media have long been proven to help students understand concepts more tangibly (Hein, 2019). However, challenges such as limited tools and time make using concrete media not optimal. Therefore, using technology such as virtual demonstration can be a solution to strengthen students' learning experience visually and interactively.

Virtual demonstration, which integrates digital media in the visualization of scientific processes, is considered capable of overcoming the limitations of direct demonstration while strengthening students' conceptual understanding of scientific phenomena (Wijaya et al., 2022). This is the background of the importance of examining the effectiveness of using concrete media supported by virtual demonstration in science learning.

This study is critical because it concerns the development of learning strategies based on the needs of elementary school students, who psychologically require concrete and visually appealing learning media. In the context of 21st-century education, using technology in the teaching-learning process is one of the key competencies of teachers (Trilling & Fadel, 2009). Therefore, developing a learning model that combines concrete media and virtual demonstration aligns with modern pedagogy principles.

Damayanti et al. (2021) showed that using digital-based interactive media can significantly increase students' learning motivation and understanding of science concepts. In addition, Yuliani and Hartono (2022) found that students who learned with the help of virtual simulation showed higher learning outcomes than those who used conventional methods.

From a socio-cultural perspective, this study is critical because it can facilitate teachers in resource-limited areas to still provide meaningful learning through the help of more flexible and cost-effective digital technology.

If this topic is studied, it will improve the quality of science learning in elementary schools, especially in the pedagogical domain and learning media. This

research can produce practical and applicable learning models and help teachers present contextual and fun learning. Conversely, if this topic is not studied, then science learning in elementary schools will continue to face challenges in transforming abstract concepts into concrete and meaningful learning experiences. This can have implications for students' low understanding of basic science concepts, which hinders the development of their science literacy at higher education levels.

This study examines the effectiveness of using concrete media assisted by the virtual demonstration on learning outcomes and understanding of science concepts of fourth-grade students. This focus was chosen because an in-depth understanding of science concepts from an early age is the foundation for forming scientific thinking skills (Harlen, 2010). The study will measure student learning outcomes before and after the application of the media, as well as assess student perceptions of the learning model used.

This study used a quantitative approach. The research subjects were fourth-grade students divided into the experimental group (concrete media + virtual demonstration) and the control group (concrete media only). The instruments used included learning outcome tests and student perception questionnaires. Data analysis was conducted using a t-test and a gain score test to determine the improvement of learning outcomes and the significance of the difference.

Previous research that shows the effectiveness of technology in science learning is as follows. First, Handayani et al. (2021) found that using Augmented Reality (AR) based learning media improved the science learning outcomes of elementary school students. Second, Kusumawati et al. (2022) examined the effectiveness of interactive learning videos on the material of changes in the form of objects and found a significant increase in concept understanding. Third, Nasution and Rizal (2020) stated that virtual demonstrations increase student engagement and concept understanding in science learning.

The similarity between this research and previous research is the focus on improving science learning outcomes and using technology as an assistive medium. However, the difference lies in integrating concrete media and virtual demonstration, which has not been studied simultaneously. This approach combines the advantages of concrete learning and digital technology in one integrated

learning model.

This study has high significance in the development of science learning in elementary schools because it offers innovative learning media that are contextual, applicable, and in accordance with the characteristics of students' cognitive development. This research also supports the development of technology-friendly learning models and the Merdeka Curriculum's implementation, emphasising project-based learning and concept understanding.

Based on the description above, the formulation of this research problem is "Is there a significant difference in science learning outcomes between students who learn using concrete media assisted by virtual demonstration and students who learn using concrete media without virtual demonstration in grade IV elementary school?". Based on the formulation of the problem, the purpose of this study is "To determine the difference in science learning outcomes between grade IV elementary school students who learn using concrete media assisted by virtual demonstration and students who learn using concrete media without the help of virtual demonstration."

The following is a hypothesis formulation based on the formulation of the problem and research objectives stated above. **Null Hypothesis (H_0):** There is no significant difference in science learning outcomes between students who learn using concrete media assisted by virtual demonstration and students who learn using concrete media without the help of virtual demonstration in grade IV elementary school. **Alternative Hypothesis (H_1):** There is a significant difference in science learning outcomes between students who learn using concrete media assisted by virtual demonstration and students who learn using concrete media without the help of virtual demonstration in grade IV elementary school.

LITERATURE REVIEW

Constructivism Learning Theory

Concrete media-based learning and virtual demonstration are rooted in the theory of constructivism, which states that students actively construct knowledge through interaction with the environment and authentic learning experiences. Jean Piaget suggested that in the concrete operational stage (ages 7-11 years), children more easily understand concepts through tangible objects and direct experience (Santrock, 2021). Therefore, concrete media are very suitable for the learning characteristics of

elementary school students.

Lev Vygotsky also emphasised the importance of social interaction and using tools in learning. Virtual demonstrations can serve as *scaffolding* that helps students understand scientific processes that are difficult to observe directly (Vygotsky, 1978). Thus, combining concrete media and virtual demonstration theoretically supports meaningful learning.

Concrete Learning Media

Concrete media is learning media that students can touch, see, and manipulate directly, such as models, props, and real objects. Hein (2019) states that concrete media are very effective in science learning because they can link abstract concepts with the reality experienced by students. Learning with concrete media can also improve students' retention and understanding of scientific concepts (Arsyad, 2020). Concrete media also increases students' active participation because it allows direct exploration and investigation of the phenomena being studied.

Virtual Demonstration in Learning

Virtual demonstration is a technology-based learning presentation that displays simulations or visualizations of scientific processes through videos, animations, or interactive simulations. This technology allows students to observe processes that cannot be observed directly in the classroom due to time, cost, or safety limitations (Damayanti et al., 2021). Research by Wijaya et al. (2022) showed that virtual demonstration can improve concept understanding and student learning engagement. This is because attractive visual displays can simultaneously activate students' cognitive and affective areas (Mayer, 2021).

Learning Effectiveness

Effectiveness in this context refers to learning objectives achieved using learning media. According to Slavin (2018), effective learning significantly changes students' behaviour or cognitive abilities. Learning effectiveness can be measured through a statistically significant increase in learning outcomes before and after treatment. This study measures effectiveness based on students' science learning outcomes after implementing learning with concrete media assisted by virtual demonstration, compared to concrete media without technological assistance.

METHOD

Research Approach and Design

This research uses a quantitative approach with a pre-experimental design. The quantitative approach was chosen because this research focuses on measuring the effectiveness of using concrete media assisted by the virtual demonstration on student science learning outcomes through numerical data and statistical analysis (Sugiyono, 2018). The one-group pretest-posttest design is used, which involves one group of students who are given treatment after an initial measurement (pretest) and then measured again (post-test) to see any improvement or change. This design is expressed as follows:

O_1 - X - O_2

Description:

- O_1: Pretest (before treatment)
- X: Treatment (concrete media-assisted virtual demonstration)
- O_2: Post-test (after treatment)

This design allows the measurement of changes that occur internally in the same group, so the effect of treatment can be known more accurately, even without a control group.

Population and Sample

The population in this study were all fourth-grade students at SD Negeri 1 Malangsuko, totalling 16 students. Because the population was less than 100, the researchers used total sampling, where all population members were used as research samples (Arikunto, 2006).

Location and Time of Research

The research was conducted at SD Negeri 1 Malangsuko, Tumpang District, Malang Regency, in September 2024. The schedule of activities included a pretest, implementation of learning using concrete media assisted by virtual demonstration, and a post-test.

Research Instruments

The main instrument in this study was a 20-item multiple-choice science learning outcome test. This question is designed to measure students' understanding of the material on changes in the form of objects and has been validated by experts. The test was given in two stages, namely, pretest and post-test.

Pretest to measure students' initial knowledge before treatment. Post-test, to measure students' understanding after learning with concrete media and virtual demonstration.

Data Collection Technique

Data were collected in two ways. First, learning outcome tests (pretest and post-test) are used to obtain quantitative data that can be analyzed statistically. Second, documentation includes score records, visual documentation of learning implementation, and learning devices (teaching modules).

Data Analysis Technique

Data analysis was carried out with the help of the latest version of SPSS. The analysis techniques used are as follows.

1) The normality Test (Shapiro-Wilk) determines whether the data is usually distributed.

2) A homogeneity test ensures that the variance between pretest and post-test data is homogeneous.

3) A paired sample t-test was used to determine significant differences between the pretest and post-test results.

The statistical hypotheses tested are as follows.

- H_0: There is no significant difference in learning outcomes after using concrete media-assisted virtual demonstration.
- H_1: There is a significant difference in learning outcomes after using concrete media-assisted virtual demonstration.

The decision is based on the significance value (p-value). If $p < 0.05$, then H_0 is rejected, and H_1 is accepted.

RESULT AND DISCUSSIONS

Result

This research was conducted at Cristal Private Senior High School. The population of this study is 200 grade 11 students of the Natural Science of Cristal Senior High School. Purposive sampling was utilized to determine the classroom. The class is composed of 22 students 12 females and 10 males.

Description of Student Learning Outcomes Data

This study aims to determine the effectiveness of using concrete media assisted by the virtual demonstration on science learning outcomes of fourth-grade students at SD Negeri 1 Malangsuko. Data were obtained through learning outcome tests in two

stages: pretest and post-test.

Pretest Results. The average score of students' pretest before treatment was **50.00**. This shows that students' understanding of science material, especially changes in the form of objects, was still relatively low before using concrete media assisted by virtual demonstration.

Post-test Results. After being given treatment in the form of learning using concrete media assisted by virtual demonstration, the average post-test score increased to **68.75**. This increase shows a positive change in student learning outcomes after the learning intervention is given.

Statistical Test Results

To determine the significance of the difference in learning outcomes between the pretest and post-test, a **paired sample t-test** was conducted using SPSS software.

1) **Normality Test (Shapiro-Wilk).** Based on the normality test results, the pretest and post-test data were normally distributed with a significance value > 0.05. This fulfils the requirements for the parametric t-test.
2) **Homogeneity Test.** The homogeneity test results show that the data is homogeneous and valid for the difference test analysis.
3) **Paired Sample t-test.** The paired sample t-test results show a significance value (2-tailed) of **0.000 <0.05**. This means there is a **significant difference** between students' pretest and post-test scores

Thus, the **null hypothesis (H_0) is rejected,** and **the alternative hypothesis (H_1) is accepted**.

Interpretation of Results

The statistical analysis results show that using concrete media assisted by virtual demonstration in science learning **significantly improves student learning outcomes**. The increase in the average score from 50.00 to 68.75 shows that this medium is effective in helping students understand the material of changes in the form of objects more concretely and visually.

Concrete media provides students with direct experience following Piaget's concrete operational cognitive development stage. Meanwhile, virtual demonstration helps bridge the understanding of concepts that are difficult to observe directly through visualisation and simulation. The combination of the two is proven to be able to create

more meaningful learning and have a positive impact on the achievement of learning outcomes.

Summary of Findings

Based on the description above, the findings of this study are presented as follows.

1) Average pretest score: **50,00**
2) Average post-test score: **68,75**
3) Significance value (t-test): **0,000 (p < 0,05)**
4) **Conclusion:** Using concrete media assisted by virtual demonstration effectively improves science learning outcomes of fourth-grade students.

Discussions

The results of this study indicate that the use of concrete media assisted by virtual demonstration significantly improves student learning outcomes in science subjects, especially on the material of changes in the form of objects. The increase in the average score from 50.00 (pretest) to 68.75 (post-test), which is supported by the results of the **paired sample t-test** (p = 0.000 <0.05), confirms that the integration of concrete media and virtual technology can significantly improve the understanding of scientific concepts in elementary school students.

Effectiveness of Using Concrete Media and Virtual Demonstration

This finding supports constructivist learning principles, emphasising the importance of direct learning experiences and students' active involvement in constructing knowledge (Piaget, 1976; Vygotsky, 1978). At the concrete operational stage of development, elementary school children need real learning media that can be touched or manipulated (Santrock, 2021). Concrete media meets this need, while virtual demonstration complements the visualization aspect of scientific phenomena that are difficult to observe directly.

The integration between these two types of media creates a **multimodal learning environment**, which theoretically supports the *dual coding theory* (Paivio, 1986) and *cognitive theory of multimedia learning* (Mayer, 2021). When students acquire information through visual and verbal channels simultaneously, the opportunity for conceptual understanding increases as dual information processing occurs in working memory.

Contribution to Science Learning Outcomes

Science learning requires understanding abstract concepts that are often difficult to explain only through lectures. This research confirms that interactive and visual science learning can increase students' absorption of the material. This is in line with the findings by Damayanti et al. (2021) and Wijaya et al. (2022), which show that using interactive digital media, such as simulations or demonstration videos, significantly increases student motivation and learning outcomes. In the context of the Merdeka curriculum, which emphasizes experiential learning and strengthening the learner profile of Pancasila, this approach is also highly relevant. Concrete media assisted by virtual demonstration facilitates cognitive understanding and encourages curiosity and scientific thinking from an early age (Kemdikbudristek, 2022).

Relevance to the Primary School Context

This finding also confirms the pedagogical relevance that primary school students learn better through concrete, active, and experiential learning strategies (Bransford et al., 2000). Learning effectiveness will increase when learning media are aligned with students' developmental characteristics. This is also emphasized in the *Universal Design for Learning (UDL)* approach, which advocates using various media to reach diverse learning styles (CAST, 2018). In this study, students are not only recipients of information but also active participants involved in the learning process by manipulating concrete objects and observing virtual demonstrations. This facilitates inquiry-based learning and simple problem-solving, essential competencies in science education.

Comparison with Previous Research

The results of this study are consistent with previous studies. Damayanti et al. (2022) reported that digital-based video demonstration media significantly improved elementary school students' science learning outcomes. Another study by Nasution and Rizal (2020) showed that virtual lab-based learning can increase students' engagement and cognitive achievement in science materials. However, this study combines both, unlike previous studies that only rely on virtual simulation or concrete media separately. This combination allows students to get physical and digital representations of the concepts learned, thus strengthening their understanding through a complementary multimodal approach (Moreno & Mayer, 2007).

Theoretical and Practical Implications

This study has both theoretical and practical implications. Theoretically, the findings strengthen the validity of *cognitive load theory*, which suggests that material should be presented effectively by reducing unnecessary cognitive load (Sweller, 2010). Teachers can facilitate optimal and efficient learning by using concrete objects as physical representations and demonstration videos as visual reinforcement. Practically, the results of this study encourage teachers to be more creative in combining various types of learning media according to the characteristics of the material and students. Implementing this strategy can be a model in developing teaching tools based on *Technological Pedagogical Content Knowledge* (TPACK) for science learning.

CONCLUSIONS

Conclusions

Based on the results of data analysis and discussion, the following conclusions can be drawn:

1) Concrete media assisted by virtual demonstration is proven effective in improving the science learning outcomes of fourth-grade elementary school students, especially on the material of changes in the form of objects. This is indicated by an increase in the average score from the pretest (50.00) to the post-test (68.75), as well as the results of the paired sample t-test, which shows a significance value of 0.000 ($p < 0.05$)

2) Integrating concrete media and virtual demonstration creates a multimodal and interactive learning environment in accordance with the characteristics of students' cognitive development at the concrete operational stage. Concrete media provides real-life experience, while virtual demonstration visualises abstract scientific processes.

3) This approach is relevant to the principles of the Merdeka Curriculum, which emphasizes active, contextual, and learner-centred learning. Thus, this learning model can be used as an alternative science learning strategy that supports the improvement of students' science literacy and critical thinking skills from an early age.

Recomendations

Based on the research findings, the authors provide the following suggestions.

1) For Teachers. Teachers are advised to further utilize concrete media and virtual demonstration in science learning, especially on abstract material. These two

types of media are proven to increase student engagement and strengthen understanding of scientific concepts.

2) For Schools. Schools must be supported by providing simple technology facilities and infrastructure, such as projectors and multimedia devices, to support virtual demonstration-based learning. In addition, training on the utilization of learning technology for teachers also needs to be carried out on an ongoing basis.

3) Future researchers should develop learning models based on concrete media and virtual demonstration at other grade levels and materials in science subjects or across subjects. Further research can also expand the focus on affective aspects and students' science process skills.

4) For Curriculum Developers. The results of this study can be used in designing science learning strategies based on technology and hands-on experience, in line with the spirit of the adaptive and contextual Merdeka Curriculum.

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