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Effectiveness Digital Diorama Media To Improve Students' Concept Understanding Of Food Chain Material In Elementary School

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ABSTRACT
This study was prompted by students' difficulties in understanding food chain concepts in science education. The fact that the current generation is a digital generation accustomed to technology also supports the importance of innovation in learning. There are still many teachers who teach using conventional methods, so learning media are needed that can facilitate understanding of abstract concepts. This research attempts to examine how well digital diorama media works as an educational innovation that can improve students' comprehension of the food chain concept. This study utilized a quasi-experimental approach using a non-equivalent control group design. In this study, sixty fifth-graders from Karawang Regency's SD Puri Artha participated. Students were split up into two groups: the experimental group used digital diorama material, and the control group used traditional means. Data were obtained through concept understanding tests before and after the intervention, as well as observations and interviews. According to the study's findings, pupils who used digital dioramas to learn had a significantly higher conceptual grasp than those who used traditional methods ($p<0.05$). There was an increase in the average value of the experimental class by 27.4. Students can more easily comprehend the relationships between organisms in the food chain with the help of digital diorama media, which can clearer visual representation. Additionally, pupils actively participate in the learning process and exhibit interest in it. The conclusion of this study is that digital diorama media is not only effective in enhancing students' understanding of the food chain concept but also in increasing students' learning motivation.
Keywords*: digital diorama media; food chain; concept understanding; innovative learning*

ABSTRAK

Penelitian ini dilatarbelakangi oleh kesulitan siswa dalam memahami konsep rantai makanan dalam pendidikan IPA. Fakta bahwa generasi saat ini adalah generasi digital yang terbiasa dengan teknologi juga mendukung pentingnya inovasi dalam pembelajaran. Masih banyak guru yang mengajar dengan meotode konvensional sehingga diperlukan media pembelajaran yang dapat memfasilitasi pemahaman konsep yang bersifat abstrak. Tujuan dari penelitian ini adalah untuk mengevaluasi bagaimana penggunaan media diorama digital, sebuah inovasi dalam pembelajaran yang dapat membantu siswa memahami lebih baik tentang konsep rantai makanan. Penelitian ini dilakukan dengan metode kuasi eksperimen dengan desain *Non-equivalent Control Group.* Penelitian ini melibatkan 60 siswa kelas V di SD Puri Artha Kabupaten Karawang. Siswa dibagi menjadi dua kelompok: kelompok ekperimen menggunakan media diorama digital, dan kelompok kontrol menggunakan metode konvensional. Data diperoleh melalui tes pemahaman konsep sebelum dan sesudah intervensi, serta observasi dan wawancara. Hasil studi menunjukkan bahwa terdapat peningkatan signifikan pada pemahaman konsep siswa yang belajar dengan diorama digital dibandingkan dengan metode konvensional ($p<0,05$). Terdapat peningkatan nilai rata-rata kelas eksperimen sebesar 27,4. Media diorama digital mampu memberikan visualisasi yang lebih jelas sehingga siswa lebih mudah memahami hubungan antar organisme dalam rantai makanan. Selain itu, siswa juga menunjukkan ketertarikan dan keterlibatan aktif dalam proses pembelajaran. Kesimpulan dari penelitian ini adalah bahwa media diorama digital tidak hanya efektif dalam meningkatkan pemahaman siswa terhadap konsep rantai makanan, tetapi juga meningkatkan motivasi belajar siswa.

Kata Kunci: media diorama digital; rantai makanan; pemahaman konsep; pembelajaran inovatif

INTRODUCTION

Science education plays a crucial role in developing students' critical and scientific thinking skills. However, one of the major challenges in science instruction at the elementary and middle school levels lies in conveying complex scientific concepts that are not directly observable in the classroom (Rahmadhea, 2024). For example, understanding ecological relationships—such as those found in food chains—requires learners to mentally construct interactions among organisms that are dynamic and invisible in real-time. The concept of a food chain, which illustrates the energy flow between producers, consumers, and decomposers within an ecosystem, is foundational in elementary and middle school science curricula (Thariq et al., 2024). A strong understanding of this concept is essential, as it reflects the balance and sustainability of ecosystems in real life. However, students often struggle to conceptualize these interactions due to the complexity of ecological relationships and the lack of tangible representations in traditional classroom environments. Despite its importance, many students struggle to grasp the interconnectedness of organisms within a food chain. This difficulty arises from the dynamic and abstract nature of the topic, as well as the lack of instructional media capable of realistically representing these interactions. Moreover, the predominant use of conventional teaching methods, such as lectures and rote memorization, has been shown to hinder students' engagement and limit their understanding of scientific concepts (Suryaningsih et al., 2021). Low levels of student involvement in learning can negatively impact both motivation and academic achievement.

To address these challenges, there is a growing need for innovative instructional media that can bridge the gap between theoretical knowledge and concrete learning experinces, the use of innovative media such as digital dioramas may offer a practical solution to enhance conceptual learning. By providing concrete and immersive visualizations, digital dioramas help bridge the gap between theoretical content and real-world phenomena. These three-dimensional interactive tools can depict entire ecosystems, allowing students to simulate and observe interactions among organisms in ways that foster deeper understanding.

Therefore, innovation in learning media is needed so that students can more easily understand science concepts in a more concrete manner. Through interactive and practical learning, students can connect theory with their real-life experiences, thereby deepening their understanding and improving learning outcomes (Mu'arif et al., 2023). Despite their potential, the effective use of digital dioramas in classrooms depends on several enabling factors. These include the availability of technological infrastructure, the digital proficiency of both teachers and students, and the pedagogical readiness of educators to incorporate such tools into their instruction. Teacher training and ongoing professional development are therefore essential to ensure that these innovations are implemented meaningfully and sustainably (Mahmudi et al., 2023). Teachers can use various methods to deliver material so that students can master it, namely by using learning media (Wulandari et al., 2022). One of the elements that can make learning interesting and enjoyable is learning media (Istyasiwi et al., 2021). The use of dioramas as a learning medium can support students in strengthening concept understanding, developing logical thinking, and depicting material more realistically (Sania et al., 2024). Students can simulate interactions between producers, consumers, and decomposers in an ecosystem. A diorama is a three-dimensional miniature whose purpose is to depict a real-life situation (Nada & Gunansyah, 2023). Diorama media can be made from readily available materials, displaying objects in their entirety, and can be presented in a realistic or concrete manner. Diorama media is usually used to depict something abstract. To improve the effectiveness of education, learning in the digital era requires the use of new and interactive learning media (Utomo, 2023). Technology-based learning material has been shown to improve learning effectiveness (Fitriyani, 2024). One of the media that can be used is a digital diorama, which combines three-dimensional visualization with digital interactivity. This media allows students to explore relationships in the food chain in a more engaging and in-depth manner.

Additionally, digital dioramas can enhance student engagement in learning by providing a more immersive and interactive learning experience. Previous studies have indicated that interactive learning tools such as dioramas can enhance students' conceptual knowledge, learning motivation, and classroom participation (Qurrotaini et al., 2024) (Choiroh et al., 2024) (Sintarani et al., 2024). In the context of food chain learning, digital dioramas can help students understand concepts within an ecosystem as an inseparable reciprocal relationship between living beings and their environment. Interactive visualizations will help students connect concepts in the food chain with real phenomena in their surroundings. In addition to improving conceptual knowledge, using digital diorama media helps students become more motivated to learn and participate in class (Hendrik et al., 2021). Students who feel engaged in learning tend to have a higher interest in studying and are more active in exploring learning materials. These media can be especially effective when paired with active learning strategies such as problem-based learning (PBL), where students are encouraged to use scientific reasoning to solve contextually relevant problems (Nabila & Sutyanti, 2020). As a result, pupils not only understand the concept of the food chain, but they can also use scientific abilities to solve problems.

Digital dioramas align with pedagogical principles of 21st-century learning that emphasize technology integration, digital literacy, and student-centered engagement

(Permana et al., 2024). The application of technology in learning allows students to learn independently and enhance their digital literacy skills. Digital literacy is described as an individual's ability to use computer equipment to obtain a variety of digital information (Naila et al., 2021). However, in its implementation, there are several challenges that need to be addressed, such as the availability of technological infrastructure in schools and the readiness of teachers to use digital media in teaching. Therefore, training for teachers is necessary so that they can effectively integrate digital dioramas into the learning process. With effective learning, it is hoped that students' learning outcomes will improve. Research has shown that when students are provided with visual and interactive aids, they are more likely to retain complex scientific information and apply it meaningfully (Mu'arif et al., 2023). Research has shown that when students are provided with visual and interactive aids, they are more likely to retain complex scientific information and apply it meaningfully (Ramdan et al., 2024). Students' progress in the learning process can be measured by their achievement of learning outcomes. The purpose of this research is to evaluate how well digital dioramas can enhance students' understanding of the food chain concept. By understanding the impact of using this media, it is hoped that it can help create more innovative teaching methods, thereby improving student learning outcomes.

METHODS

This study employed a quasi-experimental method using a non-equivalent control group design, which is a variation of the pre-test and post-test control group design. Unlike true experimental designs, this approach does not involve random assignment of participants to groups (Rukminingsih et al., 2020; Abraham & Supriyati, 2022). The aim was to compare students' conceptual understanding before and after the implementation of an instructional intervention using digital dioramas. Two intact groups were used: one experimental group that received digital diorama-based instruction and one control group that received conventional instruction. Independent variable, type of instructional method (digital diorama vs. conventional). Dependent variables, students' conceptual understanding and learning motivation. The study involved 60 elementary school students, divided equally into two groups:experimental group (n = 30), received instruction using digital diorama media. Control group (n = 30), received instruction through conventional teaching methods (lectures and textbooks). The instruments used include concept comprehension tests, learning motivation questionnaires, and interviews.

Research Type and Design

The type of research above uses a Non-equivalent Control Group design. This design allows researchers to compare the improvement in students' conceptual understanding before and after the intervention using digital dioramas. The table below shows the Non-equivalent Control Group design for students' conceptual understanding before and after the intervention in the experimental group utilizing digital diorama media and the control group using traditional means:

Table 1. Non-equivalent Control Group Design before and after the intervention

Sample	Group	Pretest	Treatment	Posttest
Non Random	Eksperimen	Y1	X	Y2

Non Random	Control	Y1	-	Y2

Information:

- Y1: Pretest (Test before treatment)
- X : Learning using digital dioramas
- Y2: Posttest (Test after treatment)

Data and Data Sources

This study's quantitative data comes from test results that reveal how well students grasp concepts before and after the learning process. The scores were gathered by pretests and posttests given to students in the experimental and control classes. This test aims to measure the extent of students' understanding of food chain material before and after being treated with digital diorama media.

This research collects both quantitative and qualitative data. After the learning process is complete, the results of the student motivation questionnaire are used to collect this data. To gain further insight into the experiences of teachers and students in using digital dioramas for learning, interviews were also conducted. This qualitative data helps in understanding the factors that contribute to the effectiveness of using digital dioramas.

Participants were selected using purposive sampling, based on specific criteria such as similar initial academic ability, class level, and access to digital learning infrastructure (Husna et al., 2023). This method ensured comparability between groups and suitability for evaluating the effectiveness of digital dioramas.

Data Collection Techniques

Data is collected through various techniques to ensure the accuracy and validity of the research results. The information collection techniques used combine tests and non-tests, such as questionnaires, observations, and interviews (Lailiyah & Widiyono, 2023). Students were given concept understanding assessments before and after the treatment to assess their understanding of the food chain information. This test aims to determine the improvement in students' understanding after learning using digital diorama media (Salsabilla & Fikri, 2025). Additionally, a learning motivation questionnaire is used to measure the extent to which the use of digital dioramas affects students' learning motivation. The usage of media and approaches in learning has a substantial impact on enhancing students’ learning motivation (Irawan et al., 2023). In quantitative research, research instruments include questionnaires or surveys, structured observation checklists, and measurement instruments used to collect data that can be measured and statistically analyzed (Ardiansyah et al., 2023).

To gather additional information on how teachers and students perceive the use of digital dioramas in the classroom, interviews were also conducted with them (Purwanti et al., 2022). Through interviews, researchers can delve deeper into certain aspects of the research subjects, including views, experiences, and emotions that might not emerge through observational methods (Siti Romdona et al., 2024). The research can provide a more comprehensive picture of how well digital dioramas enhance students' conceptual understanding of food chain material by combining quantitative and qualitative methodologies.

Three instruments were used to collect data. First, concept comprehension test. Developed to measure students' understanding of food chain concepts. The test consisted of 20 multiple-choice items, validated through expert judgment by science education professionals and piloted with a separate group of students. The test's reliability was confirmed using Cronbach's Alpha ($\alpha > 0.7$). Learning motivation questionnaire: A 4-point Likert-scale questionnaire adapted from previous validated instruments, consisting of 15 items assessing students' interest, engagement, and persistence in learning science. Semi-Structured Interviews, conducted with selected students and teachers to explore perceptions and experiences related to the use of digital dioramas. Interview questions were developed based on themes from prior studies and reviewed by educational experts for content validity.

Data Analysis

The data from this research were analyzed using descriptive and inferential statistical methods. This analysis technique attempts to assess the research hypothesis and investigate the impact of employing digital dioramas on students' conceptual understanding. The steps of the analysis used are as follows:

1. **Normality Test**

The normality test determines whether the pretest and posttest data of both groups (experimental and control) are regularly distributed or not. The test was conducted using the Shapiro-Wilk Test because the sample size was less than 50. The analysis results show that the p-value for all groups (experimental and control in both pretest and posttest) is greater than 0.05. This implies that the data in this study are regularly distributed, allowing for parametric analysis to be done. Thus, the normality test has a significant impact in determining the appropriate analysis method to interpret research results more validly and reliably.

2. **Homogeneity Test**

The homogeneity test determines if the variation of data between groups is homogeneous (Dewi et al., 2023). Homogeneity of variance is one of the assumptions that must be met in parametric statistical analysis so that the results obtained are more valid and can be compared objectively. The homogeneity test determines if the variation between the two groups (experimental and control) is homogeneous. The test was conducted using Levene's Test, and the results showed a p-value > 0.05, which means the variances of both groups are homogeneous. With the fulfillment of the normality and homogeneity conditions, the t-test can be used to analyze the mean difference between the two groups.

3. **Uji t (Independent Sample t-test)**

After determining that the data is normally distributed and the variances are homogeneous, a t-test was performed to evaluate if there is a difference in results between the experimental and control groups after the therapy was provided. The t-test reveals a significant difference between the two groups (p-value < 0.05). This suggests that the treatment supplied to the experimental group has a significant impact on students' learning outcomes as opposed to the control group that did not get any treatment.

4. **Descriptive Analysis**

In addition to inferential statistical tests, descriptive analysis was also conducted to observe the patterns of students' learning motivation based on the questionnaire results. The data analysis process begins with normality and homogeneity tests to ensure the data meets the assumptions of parametric statistics. The pretest and posttest results of both groups were then compared using a t-test. If the t-test results are less than 0.05, there is a significant difference between the experimental and control groups.

RESULTS AND DISCUSSION

According to the research findings, using digital dioramas can improve students' grasp of food chain material. Data collected through pretests and posttests were analyzed using inferential statistical tests. To examine the influence of employing digital diorama media on students' conceptual understanding, beginning and end abilities were measured by pretest and posttest. The pretest was conducted before the learning process to determine the students' initial abilities, while the posttest was given after the learning to measure the improvement in learning outcomes after the treatment was applied. Both groups, namely the experimental group (which received instruction using digital diorama media) and the control group (which received conventional instruction), each consisted of 30 students.

The following are the average pretest and posttest scores for the experimental and control groups:

Table 2. Average results of pretest and posttest scores

Group	Pretest	Posttest	Increased
Eksperimen	58,2	85,6	27,4
Control	56,8	72,3	15,5

From the table above, the average pretest score for the experimental group is 58.2, while for the control group it is 56.8. The experimental group is the group that uses digital diorama media in its learning process, which is a digital-based three-dimensional visualization media designed to enhance students' understanding of the learning material through an attractive, contextual, and interactive display. This figure shows that before using the digital diorama media, both the experimental group and the control group had relatively low understanding of the food chain concept. Next, in the experimental class, learning was conducted using digital diorama media, and students were retested to measure their understanding after the learning. After the intervention, the average posttest score for the control group was 72.3, while the experimental group was 85.6. This shows that the experimental group, which used digital dioramas, demonstrated a significant improvement in understanding compared to the control group.

The table illustrates the difference between the average posttest and pretest scores for each group, indicating the extent of the students' understanding improvement. The experimental group increased by 27.4 points, whilst the control group increased by 15.5.

The following graph shows the increase in students' concept understanding scores between the control group and the experimental group based on pre-test and post-test scores

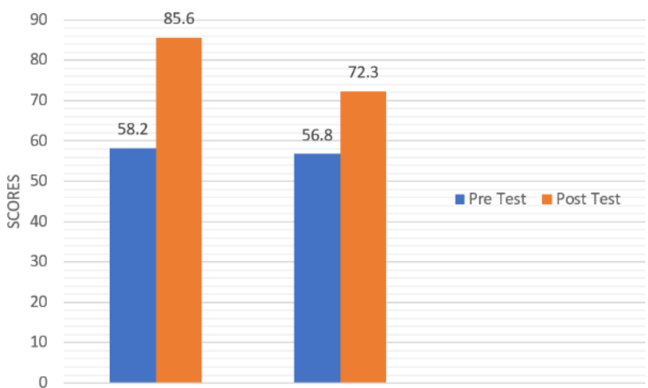

Figure 1. Improving Students' Concept Comprehension Scores

The findings indicate that students in the experimental group achieved higher average posttest scores compared to those in the control group, highlighting the effectiveness of digital dioramas in enhancing conceptual understanding. These results demonstrate that integrating digital dioramas into science instruction can significantly boost students' grasp of scientific concepts and their motivation to learn. As such, technology-enhanced learning tools like digital dioramas offer a promising and innovative approach to improving science education in schools.

The use of digital diorama media has a significant impact on enhancing students' understanding of the food chain concept. To measure the impact of using digital diorama media not only on learning outcomes but also on students' affective aspects, a learning motivation questionnaire was distributed. This questionnaire consists of several key indicators that represent the dimensions of motivation, namely attraction, involvement, and perception of effectiveness. Each indicator is measured using a 1–5 Likert scale, where higher values indicate a greater level of motivation. The questionnaire was given to all students from the experimental group and the control group after the learning process was completed. The average score results for each indicator are displayed in Table 3 below:

Table 3. Results of the learning motivation questionnaire

Motivation Indicators	**Eksperiment Average**	**Control Average**
Atraction	4,6	3,8
Involvement	4,5	3,7
Perception of effectiveness	4,7	3,9

Based on the table, it was discovered that the markers of interest, engagement, and impression of efficacy in the experimental class had higher average scores than the control class.. Interviews with students and teachers also show that the digital diorama media facilitates understanding of the food chain material and enhances student participation in learning. The results of this study are in line with previous research that shows the use of visual-based media, such as digital dioramas, can enhance students' conceptual understanding (Wardoyo et al., 2022) (Maghfiroh et al., 2023) (Rahmawati & Sati, 2021).

Visualization in digital dioramas helps students understand the relationships between components in the food chain more concretely compared to conventional lecture methods. A higher improvement in the posttest results of the experimental group shows that students who utilized digital dioramas saw a stronger increase in conceptual comprehension than students who learnt using conventional techniques. This can be explained by cognitive theory, which states that visual representations can accelerate the process of constructing conceptual understanding (Sulistiowati & Astawan, 2025).

Higher student learning motivation in the experimental group also indicates that digital diorama media can enhance student engagement in the learning process. Student motivation can come from within the individual (intrinsic motivation) or from outside the student/extrinsic motivation (Aprianto & Wahyudin, 2023). This motivation is greatly influenced by various factors, one of which is the way the lesson material is delivered. Digital media, which includes the use of the internet, learning applications, educational videos, and other devices, offers a more interactive and engaging approach compared to conventional methods (Rais et al., 2024). With engaging animations and simulations, students can more easily develop a deeper understanding of the concepts being taught (Azkia et al., 2023). This is also supported by the opinion of which states that digital media in science education can enhance learning effectiveness and increase student participation.

CONCLUSION

The research findings suggest that incorporating digital diorama media into the teaching of food chain concepts positively influences students' conceptual understanding. Students in the experimental group, who learned through digital dioramas, scored significantly higher on the post-test than those in the control group who received conventional instruction ($p<0.05$). This outcome demonstrates the effectiveness of digital dioramas in visually and contextually illustrating the interactions among organisms within an ecosystem. Beyond enhancing conceptual understanding, the use of digital dioramas also increased student motivation. Learners displayed strong enthusiasm, active engagement, and heightened interest throughout the learning process. The interactive features of digital dioramas allowed students to grasp the connections in the food chain more clearly and concretely. These findings highlight the potential of technology-based media, like digital dioramas, as innovative tools to improve science education at the elementary level. As such, implementing digital dioramas can be a promising alternative for teaching abstract or complex topics, such as ecological relationships. The study recommends broader adoption of similar media to enrich the learning experience and improve student achievement in science.

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