The Effectiveness of Interactive Learning Media in Improving Students' Understanding of the Food Chain Concept in Elementary Schools

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Abstract: The inadequate comprehension of primary school pupils about the food chain concept is a significant issue in science education, exacerbated by traditional learning tools with limited interactivity. This research seeks to analyze the effectiveness of interactive learning media in enhancing primary school pupils' comprehension of the food chain concept. The material was designed to suit primary school pupils' cognitive development and aligns with the Independent Curriculum, which emphasizes active, contextual, and technology-supported learning. A quantitative approach was used with a quasi-experimental pretest-posttest control group design. Fifth-grade students from public elementary schools in Wonogiri Regency participated as subjects. Data was collected through a 25-item multiple-choice test. Analysis included normality and homogeneity tests, hypothesis testing using an independent sample t-test, and effect size calculation. Results showed a significant difference between experimental and control groups, with a significant value of 0.049 (<0.05), indicating the effectiveness of the media. The effect size of 0.530 classified the impact as high. In conclusion, interactive learning media significantly improves students' comprehension by offering engaging and accessible learning experiences. These findings underscore the importance of integrating technology into science education to enhance learning outcomes and support student-centered approaches.

Keywords: Elementary School; Interactive Learning Media; Students' Understanding

Introduction

Science education, particularly at an elementary level, is crucial for developing pupils' comprehension of natural events and the connections among living organisms. One essential concept in elementary science education is the food chain, which explains how energy is transferred among organisms within an ecosystem and emphasizes the interdependence of living beings (Yeo et al., 2022). The food chain is a foundational topic that helps students recognize relationships between producers, consumers, and decomposers, fostering ecological literacy from an early age (Wennersten et al., 2023). However, understanding this concept requires more than memorizing definitions; it demands engaging visual representations and contextual learning experiences that connect theory to everyday phenomena (Chusna et al., 2024). Studies show that interactive media combining images, animations, and simulations can significantly improve students' conceptual comprehension and critical thinking skills (Rangkuti & Fakriza, 2024). Moreover, The rapid advancement of information technology now aids in enhancing human actions related to recalling encountered occurrences (Pea, 2018).

How to Cite:

In the contemporary digital age, the integration of technology in scientific education has become essential for fostering a more significant learning experience (Afandi et al., 2019; Rosen et al., 2023). Contemporary educational trends are progressively adopting digital technology, enabling students to engage in more interactive and autonomous learning (Mufit et al., 2023; Selfa-Sastre et al., 2022). For instance, in the realm of education, these services operate as learning mediums (Ostrom et al., 2015). Integrating technology into lessons has been proven to improve student motivation and facilitate better retention of complex scientific concepts (Awfi et al., 2024).

Field observations provide several intriguing gaps for investigation. While optimal comprehension of the food chain concept requires engaging visuals and interactive experiences, many educators continue to depend on basic textbooks and PowerPoint presentations. The acquired data is alarming; the average comprehension of pupils about the idea of the food chain is at 42.70, much below the KKM (minimum completion criteria) threshold of 75. Concerningly, around 68% of students remain perplexed regarding the interconnections among food chain components, 72% lack comprehension of energy flow inside the food chain, and 75% struggle to relate the notion to quotidian experiences (Darmono & Wenda, 2022). Initial observations of researchers in many primary schools in Wonogiri in 2024 revealed that the scientific subject scores remained quite low. The data indicates that the average science score at SDN 3 Slogohimo is 64.3, with only 38.1% of students meeting the KKM, but in SDN 2 Nadi, the average score is 57.3, with 14.3% of students meeting the KKM. Despite SDN 2 Sidokarto exhibiting a superior average of 72.2, this statistic remains suboptimal since only 42.9% of students attained the established KKM (minimum completion criteria).

The inadequate performance in scientific education throughout the three institutions signifies significant issues within the learning process, particularly with conceptual comprehension and student engagement. Further study indicates that the poor average results in the three schools are strongly associated with the use of traditional and less interactive learning resources. The substantial disparity in scores among students is evident, with SDN 3 Slogohimo exhibiting a score range of 40-85, SDN 2 Nadi ranging from 31-93, and SDN 2 Sidokarto showing scores between 64-86. This underscores the necessity for innovative approaches in learning methodologies and resources to enhance comprehension for all students. The disparity becomes further apparent when examining the use of technology in education. Approximately 85% of students are acquainted with the internet and electronic devices at home. Ironically, its use in scientific education remains somewhat restricted. The poll revealed that just 15% of educators use technological learning media, with an astonishing 5% using interactive media. This scenario is unequivocally at odds with the requirements of contemporary education, which underscores the significance of technological integration in learning (Atun & Latupeirisa, 2021; Huang et al., 2022). Multiple reasons contributing to students' inadequate comprehension include a teacher-centered learning approach, restricted access to interactive educational materials, and little integration of technology in the learning process. This issue requires urgent attention since the notion of the food chain is fundamental for comprehending the ecosystem as its whole (Foster & Yaoyuneyong, 2016; Garcia et al., 2019). Given these circumstances, the use of digital interactive learning media presents an efficient approach for enhancing primary students' comprehension of the food chain idea. Digital interactive media integrates diverse elements, including text, images, animations, videos, and audio, enabling students to engage directly with learning content, thus enhancing their motivation and focus during the educational process (Chusna et al., 2024). This interactive media may enhance the comprehension of abstract ideas via representations and simulations tailored to the cognitive development stage of primary school kids (Kafle, 2024).

The effectiveness of digital interactive media has been shown to markedly enhance student learning outcomes, foster autonomy in learning, and cultivate critical and collaborative thinking abilities among students. Research indicates that the use of interactive multimedia may enhance students' comprehension of educational texts by as much as 85% relative to traditional techniques (Khan et al., 2020). To attain optimal outcomes, the implementation of this interactive learning media must be meticulously designed, taking into account student characteristics, the content of the learning materials, and the requisite digital competence of teachers, ensuring that learning occurs effectively and enjoyably for students (Chusna et al., 2024).

This research examines the effectiveness of interactive learning media in enhancing primary students' comprehension of the food chain idea. This research focuses only on primary school pupils who have adopted the Independent Curriculum, which aims to develop students' competencies and character holistically. The use of interactive media as an educational instrument aligns with the tenets of the Independent Curriculum, which promotes student-centered learning, project-based activities, and the effective integration of technology. This research is very relevant to several prior investigations addressing

improvements in digital learning mediums inside primary schools. This research introduces innovative interactive material tailored for primary school pupils, considering their cognitive development traits, and includes aspects that enhance comprehension of the food chain idea. Prior research has extensively addressed the effectiveness of diverse digital media in education; nevertheless, there is a paucity of studies that particularly investigate interactive media for scientific curricula in primary education. This research aims to provide fresh insights into the use of interactive media for enhancing students' conceptual comprehension and to augment the literature on innovative technology learning resources.

The urgent need for this study stems from the pressing demand for creative educational media that enhances comprehension of academic subjects while simultaneously cultivating students' technical competencies. In the contemporary digital age, the integration of technology into education is unavoidable. In the absence of innovative adaptive learning media, the educational process may become less effective and unengaging for pupils. If education continues to depend on traditional techniques without the use of technology, the potential to enhance students' comprehension of academic content would be further constrained.

Prior investigations on analogous subjects include the study by Darmono & Wenda (2022) on the Development of RAMA Learning Media Utilizing Kinemaster for Natural Science Education in Fourth Grade Elementary Schools. The study results indicated a substantial rise in pre-test and post-test scores. Research conducted by Fardiana et al. (2023) focused on the Development of Science Diorama Media about Food Chain material for Grade V at Ellak Laok IV Elementary School. The analysis of the data derived from student replies indicates a 95% approval rate, concluding that students' reactions to the production of scientific diorama media on food chain material for fifth grade at SDN Ellak Laok IV are very favorable.

Research conducted by Andriani et al. (2024) indicated that the N-Gain value for skill mastery in the experimental group was 0.5%, but the control group achieved just 0.3%. The experimental group exhibited an average critical thinking ability score of 80.77, while the control group recorded an average score of 76.31. The findings indicate that the use of virtual labs enhances students' conceptual comprehension and critical thinking abilities within the Science Concept area.

This study's innovation is in the use of interactive learning media aimed at enhancing comprehension of food chain concepts. This pertains to the evaluation of interactive learning media vs traditional learning media

to assess the effectiveness of each model in enhancing student's comprehension of the food chain concept. This research will specifically investigate the outcomes of the instrument examination, assessing students' knowledge of scientific topics of the food chain, culminating in the degree of comprehension achieved by each student.

This research seeks to analyze the effectiveness of interactive learning media in enhancing students' comprehension of the food chain concept. This study advances views on technology's role in education and offers actionable recommendations for educational policy aimed at enhancing the effectiveness of scientific instruction in primary schools. This study's outcomes are anticipated to provide both theoretical and practical advances. This research will theoretically enhance knowledge of the effectiveness of interactive learning media in facilitating comprehension of academic topics in primary science education. This research will provide suggestions for educators, institutions, and educational policymakers about the development and implementation of interactive media within technological learning innovations. This research enhances comprehension of the significance of technology integration in elementary education and presents tangible methods for maximizing digital learning media to elevate the quality of learning in primary schools.

Method

Research Method

This study employs a quantitative approach using a quasi-experimental research design to assess the effectiveness of interactive learning media in enhancing primary school students' comprehension of the food chain concept. This research used a quasi-experimental pretest-posttest design with a control group, as defined by Sugiyono (2017), where both the experimental and control groups undergo assessments before and after the intervention to evaluate its effects. The research design is shown in the following table:

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O3		O4

Time and Place of Research

This research was carried out at many public elementary schools in Wonogiri Regency, focusing on fifth-grade pupils during the even semester of the 2024/2025 academic year, occurring from October to February 2025. The subjects of this research included fifth-grade pupils from public primary schools in

Wonogiri Regency during the 2024/2025 academic year, who were still adhering to the Independent Curriculum. Data from all schools will be assessed for equivalence to establish the study sample. This research had two sample groups: one experimental class and one control class. The sampling approach used was cluster random sampling since the population was categorized into groups, making it impractical to randomize all people. The lottery results were derived from class V SDN 2 Nadi and SDN 3 Slogohimo, including 36 students as the experimental group, and class V SDN 2 Sidorejo and SDN 1 Randusari, consisting of 38 students as the control group.

Tools and Materials

The main tools and materials included a multiple-choice test instrument consisting of 25 items aligned with the fifth-grade science curriculum to measure students' understanding of the food chain concept. Additionally, computers and projectors were utilized to deliver the learning media effectively in the classroom. Data collection using a test method in the form of multiple-choice questions to measure the understanding of the food chain concept totaling 25 items. The questions are arranged based on basic competencies and indicators of social science learning for grade V, even semester.

Research Stage

The research instrument has gone through a content validity test with expert judgment as well as a product-moment correlation test and reliability test. Reliability is measured using Cronbach's Alpha formula. The results of the question validity test showed that the validation results of the research instrument obtained validator I assessed with a percentage of 87.5% and validator II assessed with a total percentage of 93.75%. These results indicate that the instrument questions are valid supported by the results of the validation test using Pearson Correlation with a Sig. Value (2-tailed) on each question item <0.05. The reliability results show a Cronbach's Alpha value of 0.805> 0.6 so that all question items are declared reliable (Taber, 2018).

This research started with a pretest to assess students' initial knowledge before the intervention was carried out. Furthermore, interactive learning material was used for a short amount of time to give a more engaged learning experience in the experimental class. The control group utilized traditional media. Following the intervention, students were given a posttest to assess their improved grasp of the food chain concept in the two experimental and control groups.

Data Analysis

Data analysis is completed in three steps. This data analysis makes use of the SPSS 25 program. The first step comprises an initial examination to check for normality and homogeneity, ensuring that the data is suitable for further statistical analysis. Additionally, the hypothesis test employs an independent sample t-test. This hypothesis test determines if there is a significant difference in student knowledge between the experimental and control groups. Following that, an effectiveness test is performed to determine how much impact the interactive learning medium of the food chain material has on student's ability to grasp the food chain material using the effect size test. The table below shows the effect size test categories.

Table 2: Effect Size Categories

Magnitude of Effect Size (d)	Effect Size Category
$0.5 \leq d \leq 2.0$	High
$0.3 \leq d < 0.5$	Moderate
$0.0 \leq d < 0.2$	Low

Source: (Cohen, 1988)

Result and Discussion

Descriptive Statistical Data Results

Understanding the initial conditions of the population is very important to ensure the validity of the study. Therefore, an initial analysis was conducted to ensure that the data met the assumptions required for further statistical analysis. Population normality and homogeneity tests were conducted to ensure that the data collected were normally distributed and homogeneous so that they could be used in further analysis. The results of the descriptive statistical analysis are presented in Table 3 below.

Table 3. Descriptive Statistical Data in the Control Group

Data Type	N	Min	Max	Mean	St Dev
Pre-test	36	56	88	72.95	9.44
Post tes	36	76	100	85.68	7

Table 3 shows that there is an increase in the average value from pretest to posttest in the control group, which shows that there is a change in students' understanding after being given an intervention in the form of interactive learning media. The following is the data in the Experimental class.

Table 4. Descriptive Statistical Data in the Experimental Group

Data Type	N	Min	Max	Mean	St Dev
Pre-test	38	60	88	76.56	7.84
Post tes	38	76	100	89	7.24

Based on Table 4, there is a difference in the average value of students before and after using interactive learning media. The pre-test value shows an average of 76.56 and the average post-test value is 89. This shows that there is an increase in student understanding after using interactive learning media. The following are the post-test values of students in the control and experimental groups.

Table 5. Descriptive Post-test Statistical Data on the Control and Experimental Group**s**

Group Type	N	Min	Max	Mean	St Dev
Control	36	76	100	85,68	7
Experiment	38	76	100	89	7.24

Based on Table 5, it can be seen that the average value of students' understanding of the food chain concept between the control and experimental groups is different. The experimental group using interactive learning media has a higher average value of 89 compared to the control group which is only 85.68.

Hypothesis Testing and Effectiveness Analysis

Next is the analysis prerequisite test and the hypothesis test. The following is presented in the Table 6.

Table 6. Results of Prerequisite, Hypothesis, and Effectiveness Tests

Testing	Test Type	Sig. Value	Conclude
Normality_ Pretest Experiment	*Shapiro Wilk*	0.200	Normal data
Normality Pretest Control	*Shapiro Wilk*	0.200	Normal data
Normality_ Posttest Experiment	*Shapiro Wilk*	0.074	Normal data
Normality_ Posttest Control	*Shapiro Wilk*	0.084	Normal data
Homogeneity_ pretest	*Levene*	0.240	Homogeneous data
Homogeneity_ posttest	*Levene*	0.959	Homogeneous data
Balance test	*Independent Sample t-test*	0.079	There was no significant difference in group means
Hypothesis test	*Independent Sample t-test*	0.049	There is a significant

Testing	Test Type	Sig. Value	Conclude
			difference in the group's average
Effect Size test	*d Cohen's*	0.53	There is a high effect between groups

Based on Table 6, the results of the normality and homogeneity tests, it is known that the calculation results obtained a significance value of > 0.05. With this value, it shows that the research data is normally distributed and homogeneous. Furthermore, a balance test was carried out with a significance value of 0.079 > 0.05. From the results of the balance test, it was concluded that there was no significant difference in the average of the experimental and control groups. Hypothesis testing was carried out to determine whether the interactive learning media developed were effective or not. Based on the results of the tests carried out, a significance value was obtained on the independent sample t-test of 0.049 < 0.05. From these results, it can be indicated that there is a significant difference in the average of the experimental and control groups. This means that interactive learning media is effective in improving mastery of the material, especially on the food chain material for grade V elementary school students. The effect size test was carried out to determine how much influence interactive learning media has on students' ability to master the food chain material. Based on the calculation results, using d'Cohen, a value of 0.530 was obtained. This value is in the range of 0.5 - 2.0, which means that the effect given is high. Thus, the use of interactive learning media in the experimental class has a high influence on the ability to master food chain material.

Effectiveness of Interactive Learning Media

This study's findings demonstrate that interactive learning media effectively enhance elementary students' comprehension of the food chain idea. The statistical analysis reveals a significant difference in the averages of the experimental and control groups for student knowledge, with a significance value of 0.049, which is less than 0.05. The effect size value (d = 0.530) falls into the high category, indicating that the interactive intervention significantly impacts student learning outcomes.

The findings of this research align with other prior studies that similarly demonstrate the effectiveness of interactive learning media in enhancing educational achievements. Research by (E. T. Agustina, 2013; Sahronih et al., 2019) indicates that the implementation of interactive multimedia in education markedly

enhances student engagement and learning outcomes, achieving an average effectiveness of 38.88% among elementary school students, with media quality validation scoring 4.38 in the very good category. Further research by Rangkuti & Fakriza (2024) corroborated that the advancement of interactive online learning apps enhances student motivation, conceptual comprehension, and active engagement in the educational process. This study's results reinforce prior findings indicating that interactive learning media enhance comprehension of academic ideas and promote increased student engagement in the learning process. The use of interactive media in education offers students the ability to access resources at any time and from any location, whilst enhancing their digital literacy competencies.

The effectiveness of interactive learning media in enhancing student comprehension is determined by numerous key elements, including students' judgments of the medium's usability, prior technological learning experiences, and the quality of the implemented learning design. Research by Sahronih et al. (2019) indicates that the kind of interactive multimedia has the most significant impact on primary students' scientific learning outcomes, particularly in the subject of Biology, with an effectiveness rate of 41.77%. Simultaneously, I. Agustina et al. (2021) underscore the significance of media design that is engaging, interactive, and aligned with students' educational requirements to facilitate autonomous learning. Consequently, interactive media learning methodologies using animation, video, and direct assessment may enhance student engagement and comprehension significantly.

The degree of student engagement when using interactive learning media significantly affects its effectiveness in education. Research indicates that interactive digital media is more efficacious when students engage actively in the exploration of content, including tasks such as completing exercises, traversing animations, or listening to dynamic renderings of concepts. Furthermore, prior familiarity with technology is a significant consideration. Research by Chusna et al. (2024) indicated that pupils proficient with digital devices are more amenable to and engage with interactive media, positively influencing their comprehension. The effectiveness of interactive learning media is contingent upon student engagement, the presence of sufficient digital infrastructure, and pedagogical practices aimed at enhancing student participation.

Husein et al. (2024) elucidated via their study that media or multimedia used in the educational process may provide diverse learning experiences for students, hence facilitating their comprehension of the subject presented by the instructor. By comprehensively grasping the topic, students enhance their ability to attain learning objectives. Sahronih et al. (2019) similarly discovered in their study that the use of interactive learning media enhances students' comprehension of the subject presented.

The use of interactive learning media may enhance the academic performance of pupils. Mar'atunshalihah & Suyadi (2019) assert that interactive learning media enhances the average marks attained by pupils. The rise in grades indicates that pupils have comprehended the content presented by the instructor. Additional research indicates that interactive learning media significantly affect learning results and student motivation (Maulidya & Astuti, 2025). The previously mentioned results indicate that interactive learning media effectively enhance the mastery of scientific topics related to the food chain among fifth-grade primary school pupils. Consequently, educators should use interactive learning media to enhance the effectiveness of scientific instruction about food chain concepts.

This study's findings demonstrate that interactive learning media effectively enhance elementary students' comprehension of the food chain idea. Interactive learning offers flexibility in access, enabling students to freely comprehend the subject via many media, including text, graphics, and videos. Moreover, interactive media elements promote student participation in conversations and reflections, serving as a tool that not only augments conceptual comprehension but also improves the educational experience. The incorporation of modern media in education underscores the significance of teacher preparedness in adopting technology to enhance the learning process.

This research has some limitations that need consideration. The study's restricted scope needs more investigation to generalize the findings to a broader population. This research primarily emphasizes conceptual comprehension, resulting in limited exploration of other areas such as critical thinking abilities and teamwork. The limitations of technological access in some schools provide a hurdle to the implementation of interactive learning as a medium. Consequently, the next study may broaden the sample size and include a project-based or collaborative learning methodology to more thoroughly cultivate 21st-century abilities.

Conclusion

Interactive learning media has shown effectiveness in enhancing primary students' comprehension of the food chain idea. This multimedia presentation, including text, photos, videos, and animations, fosters

an engaging learning experience, enhances visual comprehension of topics, and promotes active student participation in the educational process. The study's findings indicated a substantial rise in scores from pretest to posttest, corroborated by a large effect size value (d = 0.530). The accessibility and interactive features of this medium enhanced motivation fostered learning autonomy, and facilitated a more profound comprehension of the content. The study's findings showed that the significance value of the independent sample t-test was 0.049, which is less than 0.05, demonstrating a significant difference in the average knowledge of students between the experimental and control groups.

The effectiveness of interactive media is significantly affected by several elements, including the preparedness of digital infrastructure, the proficiency of educators in using technology, and the adaptability of learning design to student characteristics. Constraints, like restricted access to gadgets in some institutions and the study's emphasis mostly on conceptual comprehension, are significant considerations for future progress. Consequently, a more comprehensive implementation plan and continuous teacher training are essential to optimize the effectiveness of interactive media in education.

The ramifications of these results underscore the need to create digital learning media that account for both technology elements and suitable pedagogical integration. This research advocates for governmental assistance to enhance teacher proficiency in using digital media and to provide equal access to learning facilities, so facilitate fair and effective technology-based education for all students. Consequently, interactive learning media can serve as an innovative option for enhancing the quality of scientific education in primary schools sustainably.

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