Carving The Future with Interactive Audio-Visuals: A Breakthrough in Enhancing Environmental Science Literacy

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Abstract. The lack of student engagement and difficulty in visualizing abstract concepts are notable challenges in education. Audio-visual learning media emerges as an optimal solution, enhancing student involvement through engaging methods and facilitating the understanding of concepts via effective visualization. Therefore, this research aims to understand how interactive audio-visual learning media can improve environmental literacy in science and technology, as well as to identify its impact on enhancing student learning outcomes. This study employs a quantitative method to explore educational phenomena at Public Elementary Schools in the Rappocini Subdistrict, Makassar City, in 2019. The research population consists of 59 fourth-grade students. For sample selection, the researcher used purposive sampling technique. Data analysis in this study was conducted using descriptive and differential statistical analysis techniques. The findings reveal that the use of interactive audio-visual media significantly enhances environmental and science and technology literacy among fourth-grade students. The experimental group, which utilized audio-visual media, showed a more notable improvement compared to the control group. Hence, the integration of audio-visual technology in education is crucial to enrich learning experiences and enhance the understanding of scientific concepts and environmental awareness among young learners.

Key words: interactive, audio, visual, science, literacy

1 Introduction

The advancement of science and technology has brought significant changes to various aspects of life, including formal education [1]–[3]. Education, a conscious and planned effort to create an effective learning environment and process, plays a crucial role in developing the potential of individuals and society [4]–[6]. This forms the foundation for nations to create exceptional human resources capable of competing in the future

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with a mastery of science and technology [7]–[9]. In the context of learning, educational media holds a significant role [10], [11]. The right choice of educational media should consider the learning objectives, teaching materials, and student characteristics [12]–[14]. The effective use of media, especially in enhancing science literacy and 21st-century competencies, can significantly contribute to the development of students' critical thinking skills. For instance, for elementary school students typically at the concrete operational thinking stage, concrete learning media that can be directly operated are extremely helpful in understanding taught concepts[15]–[17].

Educational media plays a crucial role in the world of education, not just as a teaching aid, but also as a catalyst that enriches and enhances the learning process[18]–[20]. The diverse forms of media, ranging from audiovisual to interactive, are designed to meet the varied needs of students, ensuring that each individual has equal opportunities to learn and grow [21], [22]. This approach is vital in creating an inclusive and effective learning environment, where each student can absorb knowledge according to their learning style. In the context of the 2013 Curriculum, the role of the teacher as a learning facilitator becomes crucial. Teachers are required not only to have competencies in pedagogy, personality, social, and professional fields, but also the ability to integrate effective learning media into the curriculum. Pedagogical competence, in particular, is key here, as it demands teachers understand and apply learning strategies that can motivate and enhance student understanding [23], [24]. Thus, mastery of learning media by teachers not only aids in knowledge transfer but also plays an important role in developing students' attitudes, knowledge, and skills overall.

One form of educational media that is evolving is audiovisual learning media. This media serves not just as a teaching tool, but also as a vital bridge in conveying information [25]–[27]. During the pandemic, there were specific challenges in utilizing this media, especially due to limited access to technology for some students [28]–[30]. However, the use of audiovisual media, such as educational videos, greatly assists in presenting material more interactively and engagingly, such as teaching the water cycle in fifth grade. A common issue in conventional learning is the lack of student engagement and difficulty in visualizing abstract concepts. Audiovisual learning media is an optimal solution as it can increase student engagement in an interesting way and facilitate understanding of concepts through effective visualization.

Referring to several previous studies shows the positive influence of using audiovisual learning media on student learning outcomes. For instance, Nicolaou et al.'s research acknowledges the important role of audiovisuals in the learning process, identifying the significance of interactive audiovisual media in enhancing environmental science literacy [31]. Meanwhile, Abdulrahaman et al.'s study, which aimed to understand the use of multimedia in education, was more specific in its efforts to improve understanding of environmental issues through audiovisual media [32]. On the other hand, Zhu et al.'s research, focusing more on the technical aspects of audiovisual learning in deep learning, reflects some of the technological innovations that can be used in this research [33]. However, the difference is that this study delves deeper into environmental science literacy and explores interactive methods to achieve a better understanding of environmental issues. This represents the novelty of this study,

providing a more specific and relevant contribution in facing the increasingly urgent environmental challenges. By integrating interactive audiovisual media in education, this study aims to produce a deeper understanding and awareness of environmental issues, increasingly important in the context of climate change and global sustainability. Therefore, this study aims to understand how interactive audiovisual learning media can enhance environmental literacy in science and technology, and to identify its impact on improving student learning outcomes. This research contributes significantly to developing an understanding of the role of interactive audiovisual learning media in enhancing environmental literacy in science and technology. Furthermore, the findings of this study can provide a clearer view of the impact of such media on student learning outcomes, forming a basis for the development of more effective learning strategies. Additionally, as a practical reference, this research can guide teachers in using interactive learning media to enhance students' environmental literacy in science and technology.

2 Methods

This study employed a quantitative method to explore the phenomenon of education at public elementary schools in the Rappocini District, Makassar City, in 2019. The research population consisted of 59 fourth-grade students. The researcher used purposive sampling for sample selection, which involves choosing participants based on specific criteria relevant to the research objectives. The students were divided into two groups: an experimental group of 29 students and a control group of 30 students. Data collection was conducted using two main methods. First, student learning outcome tests were administered to assess the knowledge and skills acquired by students during the learning process. This test was crucial to evaluate the effectiveness of the teaching methods applied. Second, direct observations at the research site were carried out using observation sheets. These sheets were used to gather detailed information on behavior, interactions, and product work processes in the educational environment. Such observations helped understand the real context in which learning occurred and how students interacted with the learning materials and their surroundings. Data analysis in this study was performed using descriptive and differential statistical analysis techniques. Descriptive statistical analysis was used to describe and summarize the data, providing a clear picture of the characteristics of the sample and the variables studied. Meanwhile, differential analysis was employed to determine significant differences between the experimental and control groups. This was crucial for measuring the effectiveness of the learning intervention or methods applied in the research. Thus, this study offers insights into the current state of learning at public elementary schools in the Rappocini District and the potential for future improvement and innovation in teaching methods.

3 Result and Discussion

3.1. Research Findings

The study investigated the impact of interactive audiovisuals on enhancing environmental literacy in science and technology. Prior to the intervention, a pretest and posttest were administered. These tests consisted of 20 multiple-choice questions. Students were asked to answer the questions correctly, with each response being scored. Based on the attached analysis, a statistical summary of the pretest and posttest results for the use of interactive audiovisuals in improving environmental literacy in science and technology in both the experimental and control classes is as follows:

Pretest Data for the Experimental Class
The environmental science literacy pretest for the fourth-grade students in the experimental class involved 29 participants. After obtaining the pretest data, it was processed to determine the overview of the students' pretest score distribution in the experimental class. The average (mean) score was 58.62, indicating a tendency in the data obtained from the experimental class's pretest. With a standard deviation of 13.08, it implies that the students' environmental literacy in science and technology was varied, as the actual values were significantly different from 0, indicating heterogeneous data. The standard deviation being smaller than the mean suggests that the average score represents the overall data adequately. The scores achieved by students ranged from a low of 35 to a high of 85, with a score range of 50.

Control Class Pretest Data
The environmental life science literacy pretest for the fourth-grade students in the control class involved 30 participants. After collecting the pretest data, it was analyzed to obtain an overview of the pretest score distribution for the control class. The average score was 58.27, suggesting a general trend in the data obtained from the control class's pretest. With a standard deviation of 12.875, this indicates varied environmental science and technology literacy among the students, as the actual values differed significantly from 0, reflecting heterogeneous data. The smaller standard deviation compared to the mean indicates that the average score adequately represents all the data. The scores achieved by students ranged from a low of 35 to a high of 85, with a score range of 50.

Posttest Data for Environmental Science Learning in the Experimental Class
The environmental science literacy posttest for the fourth-grade students in the experimental class involved 30 participants. After obtaining the posttest data, it was processed using SPSS 13.0 for Windows to determine the overview of the students' posttest scores in the experimental class. The average score was 80.00, indicating a tendency in the data obtained from the posttest of the experimental class. With a standard deviation of 11.22, it shows that the students' environmental literacy in science and technology was varied, as the actual values were far from 0, indicating heterogeneous data. The standard deviation being smaller than the mean suggests that the average score represents all the data accurately. The scores achieved by students ranged from a low of 60 to a high of 100, with a score range of 40.

Posttest Data for Environmental Science Learning in the Control Class
The environmental science literacy posttest for the fourth-grade students in the control class involved 29 participants. After collecting the posttest data, it was analyzed to obtain an overview of the students' posttest scores in the control class. The average score was 74.83, suggesting a general trend in the data obtained from the control class's posttest. With a standard deviation of 9.39, this indicates varied environmental science and technology literacy among the students, as the actual values differed significantly from 0, reflecting heterogeneous data. The smaller standard deviation compared to the mean indicates that the average score adequately represents all the data. The scores achieved by students ranged from a low of 60 to a high of 95, with a score range of 35.

Inferential Statistical Analysis
The results of the inferential statistical analysis are used to test the research hypothesis with a t-test at a significance level of $\alpha = 0.05$. A prerequisite for hypothesis testing is that the collected data must be normally distributed, which necessitates a normality test before proceeding with the hypothesis testing.

1. Normality Test of Data

The normality test is conducted to determine whether the pretest and posttest data are normally distributed. In this study, the Kolmogorov-Smirnov test is used for this purpose. The criterion for determining normal distribution is that the data are considered normally distributed if the obtained significance value is ≥ 0.05. Conversely, the data are deemed not normally distributed if the significance value is < 0.05. Below are the results of the normality tests for the pretest and posttest data from both the Experimental and Control groups.

Table 1. Normality Test of Pretest and Posttest for Experimental and Control Classes

Normality of Data	Kolmogorrov-Smirnov (a)	Information
Experimental class retest	0,115	0,115> 0,05 = Normal
Control class pretest	0,125	0,125> 0,05 = Normal
Experimental class posttest	0,127	0,127 > 0,05 = Normal
Control class post-test	0,132	0,132 > 0,05 = Normal

Based on the data in Table 1, the normality test results of the pretest and posttest data using the Kolmogorov-Smirnov (a) method for both the experimental and control classes show normal distribution. This is evidenced by the significance values of the normality tests being greater than 0.05. Therefore, it can be concluded that the pretest and posttest data for the experimental and control classes are normally distributed.

2. Hypothesis Test

Independent Sample T-Test of Pretest for Experimental and Control Classes.
This analysis aims to determine the differences in environmental literacy of science and technology between the experimental and control classes before the treatment. The results of the Pretest Independent Sample T-Test for the Experimental and Control Classes are as follows:

Table 2. Hypothesis Test Results of Pretest Data for Experimental and Control Classes

Data	T	Df	Probability Value	Information
Pretest and Control Class	101	56	0,920	0,920 > 0,05 = No difference

Based on Table 1, the probability value is greater than 0.05, indicating no significant difference in the environmental literacy of science and technology between the experimental and control classes before treatment. The calculated t-value of 0.920 compared to the table t-value of 1.725, with $\alpha = 5\%$ and df = 20, shows that the calculated t is less than the table t. Hence, it is concluded that there is no significant difference in the pretest data of the experimental and control classes.

Independent Sample T-Test of Posttest for Experimental and Control Classes.
This analysis is conducted with the posttest for the Experimental and Control Classes using SPSS 13. The purpose is to determine the differences in environmental literacy of science and technology between the experimental and control classes after treatment.

Table 3. Hypothesis Test Results of Posttest Data for Experimental and Control Classes

Data	T	Df	Probability Value	Information
Experimental Class Posttest and Control Class	2.095	56	0,041	0,041 > 0,05 = Difference exists

Based on Table 2, a probability of less than 0.05 was obtained, indicating a significant difference in environmental literacy in science and technology between the experimental and control classes after the application of different treatments in each class: audio-visual media in the experimental class and conventional media in the control class. If the calculated t-value of 2.095 is compared with the table t-value of 1.725, considering an α value of 5% and df = 20, the calculated t-value is greater than the table t-value. This indicates that the post-test data shows a significant difference. Based on this analysis, the null hypothesis ($H\alpha$) is rejected, meaning there is no significant effect of the application of animation media on the environmental literacy in science and technology of fourth-grade students at UPT SPF Elementary School Sangir, Kota Makassar. Conversely, the alternative hypothesis ($H\alpha$) is accepted, indicating a significant effect of the application of animation media on the environmental literacy in science and technology of the fourth-grade students at UPT SPF Elementary School Sangir.

3.2 Discussion

This study illustrates audio-visual methods in science and technology education to enhance environmental literacy among fourth-grade students at Sangir Public Elementary School in Makassar City. The methodology employed was Quasi-Experimental with a Nonequivalent Control Group Design, involving two classes: IVa as the experimental group and IVb as the control group, each consisting of 29 students. The study spanned four meetings: a pretest, two treatment sessions using audio-visual

media, and a posttest. The objective was to assess the effectiveness of audio-visual media in enhancing environmental literacy. Results showed a significant increase in environmental literacy in the experimental class after using audio-visual methods, with effectiveness rising from 80% to 95%. Statistical analysis revealed that before the treatment, both classes had low levels of environmental literacy. However, post-treatment, the experimental class achieved a high level, while the control class remained moderate.

Using the Independent Sample t-test confirmed the significant impact of animation media on increasing environmental literacy. This research is closely aligned with constructivist learning theory, which emphasizes active student interaction with learning materials, and multimodal learning theory, which supports delivering information in various sensory forms[34]–[36]. The results indicate that using audio-visual media significantly improves environmental literacy in science and technology, consistent with previous studies that found multimodal learning methods effective in enhancing students' understanding of scientific concepts and environmental literacy. This research reinforces the evidence that integrating audio-visual media in education can enrich learning experiences and improve educational outcomes in science and technology. A primary advantage of this study over previous research is its specific focus on enhancing environmental literacy through interactive audio-visual media [31]–[33]. While previous studies have recognized the significant role of audio-visual media in the learning process, this research explores its use in-depth for understanding and addressing environmental issues. Unlike prior research that generally focused on multimedia or the technical aspects of audio-visual learning, this study explicitly targets environmental science literacy. It presents a new approach to science and technology education, especially in the context of climate change and global sustainability. Thus, this study has important implications for the educational world, particularly in teaching science and technology. The results demonstrate that audio-visual methods significantly enhance environmental literacy among fourth-grade students, highlighting the effectiveness of multimodal learning methods in education. It supports using audio-visual media as an efficient learning tool, facilitating active interaction and more profound learning experiences for students. This research also provides insights for educators on the importance of integrating technology into the curriculum to enhance the understanding of scientific concepts and strengthen environmental awareness among young learners. Consequently, these findings encourage schools and other educational institutions to adopt audio-visual technology more in the learning process as an effective step to enhance students' environmental literacy and science skills.

4 Conclusion

This study demonstrates that the use of interactive audio-visual media significantly enhances the environmental literacy of science and technology among fourth-grade students at Sangir Public Elementary School in Makassar City. The research successfully identified a notable increase in literacy in the experimental class compared

to the control class. This confirms that multimodal learning methods, utilizing audio-visual media, are effective in enhancing understanding of scientific concepts and environmental awareness. However, this study has limitations, including a sample limited to one school and a lack of variety in teaching methods other than audio-visual media. For future research, it is recommended to integrate other pedagogical approaches and involve a broader sample from various educational backgrounds, as well as to evaluate the long-term impact of using audio-visual media in environmental literacy. Further research could also explore the influence of other learning technologies to determine the best methods in science and technology education, especially in the context of sustainability and climate change.

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