

EFFECTIVENESS OF MULTIMEDIA PACKAGE FOR TEACHING SCIENCE TO HEARING IMPAIRED STUDENTS AT SECONDARY SCHOOL LEVEL

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ABSTRACT: Inclusive education emphasizes the need for accessible teaching methods that cater to diverse learners, including students with hearing impairments. This study explores how the use of a multimedia instructional package can support science learning among hearing-impaired secondary school students. The objectives were to develop an accessible multimedia package for science instruction and to assess its impact on academic performance and learner engagement. A quasi-experimental pre-test/post-test control group design was employed, involving 40 hearing-impaired students from two inclusive schools. The experimental group received instruction through a specially designed multimedia package, while the control group was taught using traditional methods. Findings revealed a statistically significant improvement in the post-test scores and engagement levels of the experimental group compared to the control group. The study concludes that multimedia instruction is an effective strategy for improving science comprehension and participation among hearing-impaired learners and recommends its integration into inclusive science education practices.

KEYWORDS: Multimedia Instruction, Hearing-Impaired, Science Education, Inclusive Learning, Secondary School, Academic Achievement

1. INTRODUCTION

Science education plays a crucial role in developing analytical thinking and problem-solving skills at the secondary school level. However, it remains a challenging subject for students with hearing impairments due to its heavy reliance on verbal instruction, abstract concepts, and complex terminologies (Obi & Ozoemena, 2022). Traditional teaching methods often marginalize these learners, limiting their access to content and full participation in classroom activities (Mutanga, 2017).

In response to these challenges, multimedia instructional packages have emerged as a promising strategy for inclusive education. These packages integrate visuals, animations, captions,

sign language, and interactivity to support diverse learning needs and make abstract scientific concepts more concrete and accessible (Mayer, 2009; Supasorn & Promarak, 2015). For hearing-impaired students, visual and interactive content can bridge communication gaps and foster better conceptual understanding.

Recent studies have shown that multimedia-based instruction significantly enhances learning outcomes among students with disabilities. For example, Okpani-Okoko et al. (2024) found that hearing-impaired learners taught with multimedia tools performed better in economics than those taught through traditional methods. Similarly, interactive video and multimedia storytelling have improved vocabulary acquisition, engagement, and digital literacy in hearing-impaired learners (Ahmed, 2023; Suratman & Sari, 2022).

Building on this background, the present study investigates whether a specially designed multimedia instructional package can improve science learning outcomes and engagement among hearing-impaired secondary school students.

2. REVIEW OF LITERATURE

- i. In a study conducted by Okpani-Okoko, Ibenegbu, and Osakwe (2024), a multimedia instructional package was developed to teach economics to hearing-impaired students at the secondary school level in Nigeria. The quasi-experimental research revealed that students exposed to the multimedia tools outperformed those taught through traditional methods. The multimedia content included animations, text explanations, images, and sign language translations, which helped bridge communication gaps and made abstract economic concepts more concrete. The study concluded that such packages enhanced student motivation, participation, and comprehension. This research highlights the importance of designing visually rich, learner-friendly instructional materials tailored to the specific needs of learners with hearing loss.
- ii. Ahmed (2023) investigated the impact of multimedia storytelling on vocabulary development among hearing-impaired children in primary schools. The intervention involved digital storybooks with animations, text captions, and character-based visuals, providing context and repetition in an engaging format. Compared to a control group using only printed texts and sign language, students in the experimental group demonstrated greater vocabulary retention and contextual usage. The study emphasized the importance of narrative structures, visual cues, and repetition in enhancing language acquisition for deaf students. Although focused on English language learning, the findings are transferable to science instruction, where abstract terms also require context and reinforcement.
- iii. Suratman and Sari (2022) explored the use of interactive video content to teach digital literacy skills to hearing-impaired learners. Over three weeks, students engaged with videos enriched with text captions, visual prompts, and clickable interactive elements. The study employed a pre-test and post-test design and recorded a substantial improvement in students' digital literacy levels. The average normalized gain score was 0.72, indicating a high level of effectiveness. The researchers noted that the multimodal nature of the instruction—combining text, motion graphics, and interactivity—helped maintain attention and support knowledge retention. This finding supports the use of similar instructional approaches in content-heavy subjects like science.
- iv. In Thailand, Supasorn and Promarak (2015) developed and evaluated a multimedia learning system designed to teach arithmetic to young deaf students. The system emphasized visual clarity, minimal textual overload, and user control over pacing and repetition. The experimental group showed significantly better performance than the control group in post-tests. Students reported enjoying the lessons more and feeling more confident about their understanding. The study suggests that learner autonomy and visual reinforcement are essential features when designing multimedia tools for hearing-impaired learners. Though focused on mathematics, this principle is equally applicable in science, where step-by-step visualization aids comprehension.
- v. Wambui et al. (2021) examined hearing-impaired students' perceptions of ICT integration in teaching story grammar in English. The study involved the use of multimedia elements, including videos,

illustrations, and text on digital platforms. Survey results revealed that 89% of students felt more engaged during ICT-based lessons and reported improved understanding. The study concluded that ICT tools encouraged participation and helped reduce the instructional gap typically caused by hearing impairments. The students' positive attitudes toward ICT-based learning underline the motivational advantage of multimedia, which can be capitalized on in science instruction.

- vi. Mayer's Cognitive Theory of Multimedia Learning provides a theoretical foundation for using multimedia in instruction. According to the theory, individuals learn more deeply when information is presented in both visual and verbal forms, rather than through text or speech alone. This dual-channel processing enhances comprehension and memory retention, especially when extraneous cognitive load is minimized. Mayer's principles—such as segmenting, signaling, and multimedia principle—are directly applicable to designing instructional tools for hearing-impaired students, who rely heavily on visual content to process information. The theory supports the educational value of combining animations, images, and on-screen text, making it highly relevant for science topics that involve dynamic processes like photosynthesis or chemical reactions..”

3. SYNTHESIS AND GAP IDENTIFICATION

Across these studies, there is strong evidence that multimedia tools enhance academic achievement, engagement, and comprehension for hearing-impaired learners across various subjects including economics, language, mathematics, and digital literacy. These studies share common elements: use of visual aids, learner control, and interactivity. However, there is a noticeable gap in subject-specific research targeting science education at the secondary school level. Science often involves abstract, dynamic concepts that are difficult to convey through traditional text or sign language alone. This highlights the need for focused research on how multimedia tools can be tailored to meet the learning demands of hearing-impaired students in science classrooms.

4. OBJECTIVES OF THE STUDY

- i. To design and develop a multimedia instructional package tailored to a selected science topic, specifically intended for use by hearing-impaired secondary school students.
- ii. To examine and compare the academic performance of students who are taught using the multimedia instructional package with those taught through traditional instructional methods.
- iii. To evaluate the levels of student engagement and motivation within multimedia-based learning environments, particularly among learners with hearing impairments.

5. RESEARCH HYPOTHESIS

There is no statistically significant difference in science achievement between hearing-impaired secondary school students taught using traditional instructional methods and those taught using a multimedia instructional package.

6. RESEARCH METHODOLOGY

6.1 Research Design

The study adopted a quasi-experimental research design, specifically the pre-test/post-test control group design. This design was chosen to evaluate the effectiveness of the multimedia instructional package on the science achievement of hearing-impaired students while allowing for a comparison between experimental and control groups.

6.2 Participants

The sample consisted of 40 hearing-impaired students enrolled in two inclusive secondary schools. The participants were randomly assigned into two equal groups: 20 students in the experimental group and 20 students in the control group. The experimental group received instruction through the

multimedia package, while the control group was taught using traditional methods, such as sign language-supported lectures and printed materials.

6.3 Research Instruments

Two main instruments were employed to collect data:

- i. Science Achievement Test (SAT): A researcher-developed test designed to assess students’ understanding of the selected science topic. The test was validated by subject-matter experts to ensure content validity and reliability.
- ii. Student Engagement Questionnaire (SEQ): A structured questionnaire developed to measure learners' engagement and motivation levels during the instructional period. The questionnaire focused on behavioral, emotional, and cognitive engagement indicators.

6.4 Procedure

The study was conducted over a period of three weeks and involved the following steps:

- i. Pre-test Administration: Both groups completed the Science Achievement Test prior to the intervention to establish baseline performance.
- ii. Intervention Phase: The experimental group received instruction using the multimedia package specifically developed for the study, which included visual animations, interactive simulations, and text captions. The control group continued learning through conventional methods.
- iii. Post-test and Survey: After the instructional period, both groups were re-assessed using the same achievement test. Additionally, students completed the Student Engagement Questionnaire to gauge their level of involvement and motivation during the learning process.

7. DATA ANALYSIS AND INTERPRETATION

The collected data were analyzed using descriptive statistics to summarize students’ performance and engagement levels. To determine the statistical significance of the differences between the groups, an independent samples t-test was applied to the pre-test and post-test scores. The analysis aimed to identify whether the use of multimedia instruction had a measurable impact on students’ academic performance.

Table 1: Mean, Standard Deviation (SD), and t-test Scores of Pre-Test and Post-Test for Experimental and Control Groups

Group	N	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	t-value	p-value
Experimental	20	45.30	5.12	78.85	6.03	6.42	<0.001*
Control	20	44.90	5.45	62.40	7.12		

Significant at p < 0.05

Interpretation:

Both groups had similar performance in the pre-test, indicating comparable baseline knowledge. After the intervention, the experimental group showed a marked increase in mean scores (78.85) compared to the control group (62.40), suggesting the multimedia package enhanced learning outcomes.

The independent t-test indicates a statistically significant difference in post-test scores between the experimental and control groups (t(38) = 6.42, p < 0.001). This supports the hypothesis that multimedia instruction improves academic achievement among hearing-impaired students.

Table 2: Mean, SD and t test scores of Student Engagement

Group	N	Engagement Mean	Engagement SD	t-value	p-value
Experimental Group	20	4.15	0.45	5.11	<0.001*
Control Group	20	3.30	0.60		

(Engagement measured on a 5-point Likert scale) *Significant at $p < 0.05$

Interpretation:

Students in the experimental group reported higher engagement levels ($M = 4.15$) than those in the control group ($M = 3.30$), indicating greater motivation and involvement during multimedia-based instruction.

The t-test shows a significant difference in engagement scores favoring the experimental group ($t(38) = 5.11$, $p < 0.001$), suggesting that multimedia instruction enhances learner engagement.

Table 3: Effect Size of Experimental group

Group	N	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Cohen 'd'	Remarks
Experimental	20	45.30	5.12	78.85	6.03	2.41	Large Effect Size

The effect size (Cohen's d) for the difference in pre and post-test scores between the experimental group was 2.41, indicating a very large effect.

8. RESULTS AND FINDINGS

- Both experimental and control groups had similar baseline knowledge before the intervention.
- Students taught using the multimedia instructional package showed significantly higher science achievement compared to those taught through traditional methods.
- The multimedia group demonstrated greater improvement in understanding and retention of science concepts.
- Students in the multimedia group reported higher levels of engagement and motivation during the learning process.
- Multimedia-based instruction was found to enhance active participation and interest among hearing-impaired students.
- The effect size (Cohen's d) for the difference in pre and post-test scores between the experimental group was 2.41, indicating a very large effect.
- The findings support the effectiveness of multimedia tools in improving both academic performance and learner engagement in inclusive science education.

9. DISCUSSION

The findings of this study demonstrate that the use of a multimedia instructional package significantly improves science achievement among hearing-impaired secondary school students compared to traditional teaching methods. This aligns with Okpani-Okoko et al. (2024), who reported enhanced academic performance in economics when multimedia tools were utilized, emphasizing the potential of multimedia to clarify complex and abstract concepts. Similarly, the increased engagement and motivation observed in this study are consistent with the results of Ahmed (2023), who found that multimedia storytelling enhanced vocabulary retention and learner interest among deaf students. The higher engagement scores suggest that multimedia elements such as visuals, animations, and interactive features can create a more stimulating learning environment, which corroborates Suratman and Sari's (2022) findings on the benefits of interactive videos in increasing digital literacy for hearing-impaired learners.

Furthermore, this study supports Supasorn and Promarak's (2015) emphasis on learner autonomy and visual reinforcement, demonstrating that multimedia enables students to control their learning pace and revisit content, which is particularly beneficial for learners with hearing impairments. The results also echo the conclusions drawn by Wambui et al. (2021), who reported positive student perceptions towards ICT integration in inclusive classrooms, reinforcing the motivational advantages of multimedia learning environments. Mayer's (2009) Cognitive Theory of

Multimedia Learning further explains these outcomes by highlighting how dual-channel processing through visual and verbal means reduces cognitive load and enhances understanding, particularly for learners who rely heavily on visual inputs. Taken together, these findings suggest that multimedia instructional packages are an effective and inclusive pedagogical tool that can bridge learning gaps in science education for hearing-impaired students.

10. IMPLICATIONS

The results of this study have several important implications for educators, curriculum developers, and policymakers involved in special education and inclusive teaching. Firstly, the demonstrated effectiveness of multimedia instructional packages suggests that science educators should integrate visual and interactive technologies to better accommodate hearing-impaired students, enhancing their comprehension and engagement. Curriculum designers are encouraged to develop subject-specific multimedia resources tailored to the unique learning needs of students with hearing impairments. Additionally, teacher training programs should include modules on the effective use of multimedia tools to ensure educators are equipped to implement these instructional strategies. At a policy level, educational authorities should support the adoption of multimedia resources in inclusive classrooms by allocating funding and infrastructure, thereby promoting equitable access to quality science education for all learners.

11. CONCLUSION

This study provides compelling evidence that multimedia instructional packages significantly improve science achievement and learner engagement among hearing-impaired secondary school students. By leveraging visual and interactive content, multimedia tools help overcome communication barriers inherent in traditional teaching methods, making scientific concepts more accessible and understandable. The findings reinforce the critical role of technology in inclusive education and underscore the need for further research and development of multimedia resources tailored to diverse learner needs. Overall, the integration of multimedia instruction represents a promising approach to fostering academic success and motivation for hearing-impaired students, contributing to more equitable and effective science education.

12. RECOMMENDATIONS

Based on the findings of this study, several recommendations are proposed:

- i. **Integration of Multimedia in Curriculum:** Schools, especially those with hearing-impaired students, should incorporate multimedia instructional packages into their science curriculum to enhance learning outcomes.
- ii. **Teacher Training and Professional Development:** Educators should receive specialized training on the design and implementation of multimedia tools to effectively support hearing-impaired learners.
- iii. **Development of Accessible Educational Resources:** Educational authorities and content developers should prioritize creating multimedia materials that are accessible, user-friendly, and specifically tailored for students with hearing impairments.
- iv. **Infrastructure and Resource Allocation:** Schools should be equipped with the necessary technological infrastructure, including computers, projectors, and internet access, to facilitate multimedia-based teaching.
- v. **Parental and Community Involvement:** Encouraging parents and communities to support the use of multimedia learning at home and in school can further enhance student motivation and achievement.

13. SUGGESTIONS FOR FURTHER RESEARCH

To build upon the current study, the following areas are recommended for future research:

- i. Subject-Specific Multimedia Packages: Investigate the effectiveness of multimedia instructional tools across other science disciplines (e.g., biology, physics, chemistry) and at different educational levels.
- ii. Longitudinal Studies: Conduct long-term studies to assess the sustained impact of multimedia instruction on academic achievement and engagement among hearing-impaired students.
- iii. Comparative Studies: Compare multimedia instruction effectiveness across different types of disabilities to explore the generalizability of the findings.
- iv. Qualitative Research: Explore students' and teachers' perceptions, challenges, and experiences with multimedia learning through interviews and focus groups.
- v. Technological Innovations: Examine the use of emerging technologies such as virtual reality (VR), augmented reality (AR), and gamification in science education for hearing-impaired learners.

14. LIMITATIONS

- i. The sample size was relatively small and limited to only two inclusive secondary schools, which may affect the generalizability of the findings.
- ii. The study focused on a single science topic, so the results may not be applicable to other subjects or broader science curricula.
- iii. The quasi-experimental design did not involve random assignment, which could introduce selection bias between the experimental and control groups.
- iv. The intervention period was short (three weeks), limiting the ability to assess long-term retention and sustained engagement effects.
- v. Student engagement was measured through self-reported questionnaires, which may be subject to social desirability bias.

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