EVALUATING INSTRUCTIONAL PACKAGE FOR TEACHING MATHEMATICS FOR THE HEARING IMPAIRED STUDENTS

Abstract

This study evaluated a package for teaching algebra with sign language video to students with hearing difficulties within Oyo State, Nigeria. Seventy-four participants, comprising 37 males and 37 females, were involved in the pre-test-post-test design to assess the effectiveness of such a package. At the Federal College of Education (Special), Oyo, the reliability test returned an alpha value of 0.812 and 0.670, in which items used had very strong internal consistency among 26 hearing-impaired Economics students. The collection of data was done in three different stages: initial collation of resources, conducting a pre-test, and subsequently after six weeks, a post-test evaluation. The results show that the package strongly improved students' performances, with females doing better than males, as was confirmed by a statistically significant p-value (<0.05). It becomes obvious that the video package efficiently enriches comprehension in algebra and thus supports individual learning among students to help them be able to solve problems on their own. The findings suggest the special role that visual aids can play in the education of students with special needs. The results further suggest that video packages can be considered surrogate teachers that inculcate positive attitudes toward learning among hearing-impaired students. As an instructional strategy, this should, when implemented, lead to improved students' profile performance and a better understanding of mathematical concepts among Nigerian Colleges of Education.

Keywords: Hearing impairment; sign language; algebra; instructional package; visual learning; gender differences; educational technology.

Introduction

Most people agree that education is a tool for promoting the value and growth of the individual as well as the overall development of society. According to the National Policy on Education (FRN, 2013), every child in Nigeria should have an equal right to

educational opportunities, regardless of any disabilities. This is the primary objective of education. To give the idea of equalizing educational opportunities for all children concrete meaning, this is measured based on their ability. These comprise any impairments related to their body, senses, minds, emotions, or psychology. Alnahdi et al. (2024) identified classroom modification and appropriate instructional strategies as variable instrument that can help students with disabilities. Kaur et al. (2024) also suggested supportive strategy, intrinsic strategy and intervention techniques which can help students with hearing impairment to learn effectively. It should be noted however, that, any acceptable sign language video package should achieve the aim of maximizing potential for greater height particularly in Mathematics.

Appropriate learning experience is critical to academic achievements; schools therefore, have to provide learning experiences that will optimize academic achievements of students with hearing impairment. Therefore, it is crucial to provide students with hearing impairment efficient instructional methods in order to facilitate their effective learning and maximize their academic and future success. Inadequate delivery of instructions can result in poor response and diminished interest in learning among students with hearing impairment (Susetyo et al., 2021; Fred, 2021; Oyawole, 2021).

Ganiyu and Makinde (~~2020~~2021) opined that instructional service delivery has to do with teaching and learning activities that take place in the classroom which help students to carry out more independent work. Therefore, quality of instructional service delivery entails the extents of effectiveness to which lecturers carry their classroom teaching and learning processes. Educational provisions must be established to cater to the needs of hearing-impaired students, including instructional tools, teaching approaches, classroom settings, and management strategies. Hearing impairment should not hinder individuals from reaching their academic aspirations and personal growth. Special needs people in Nigeria have history of being neglected and discriminated among their families and communities. Indeed, their conditions were seen and perceived by many as a form of divine punishment. It is in this context that missionaries and humanitarian organizations started working with person with special needs (Cleall, 2024) particularly, those who are Deaf and Hard of hearing.

Alnahdi et al. (2024) defined Special Education as a form of instruction that was designed to meet the needs of students with disabilities, so that they can learn the same skills and information as other children in school and can be simply used interchangeably with special

needs in which the disabilities may be physical, emotional or behavioural. The term "impairment" refers to the medical condition of experiencing a loss in bodily function. According to Calcaterra et al (2023), impairment can occur when any part of the body malfunctions due to injury, disease, environmental hazards, or genetic factors. Hearing sensitivity is determined by the lowest level of sound that an animal can detect, known as the hearing threshold. Hearing loss happens when there is a reduced sensitivity to the sounds typically heard by humans. The term "hearing impairment" is commonly used to describe individuals who have a decreased ability to perceive sound in the speech frequencies. Oyawole (2021) described hearing impairment has limiting an individual from the acquisition of information or knowledge through the auditory channel. This means that they have problems with communication due to their hearing difficulties.

Mansutti et al. (2023) stated that, hearing plays a significant role in communication, when there is a problem in hearing; the person is likely to experience difficulties in communication. Language remains the main vehicle of communication where students with hearing impairment are therefore put at disadvantage in hearing community and most especially in an integrated school environment where appropriate provisions are not made to take care of the needs of this special population. Impairment is a form of physical or mental defect at the level of a body system or organ; it is any loss or abnormality in psychological, physiological, or anatomic structure or function (WHO, 2015).

People with hearing impairments represent about 10% of Nigeria population (Mba, 1995; Oyawole, 2021; Bashir et al., 2024) this category of people are deaf or hard of hearing. Person with hearing impairment often experience unusual language and communication barriers, difficulties in initiating and maintaining oral interaction, limited access to incidental learning, partial understanding of what is happening around them and difficulties in abstract thinking, This communication problem extends to socialization, education and ultimately occupation. The condition leads to resentment and hostility from their counterparts with normal hearing, rejection or denial by parents, family member or the community at large.

Sign language was developed in the deaf communities, which includes interpreters, friends and families of the deaf as well as hard of hearing (Adigun & Ajayi, 2015). Sign language have been found around the world, including communities that do not have access to education.

In addition, serving as a primary medium of communication in the deaf communities, they have become among the most popular choices for second language study by hearing students.

The status of sign language as complex and complete language that are linguistic equal of spoken language is no longer questioned. Research on the characteristics of visual language has blossomed over the years, one of the earliest written records of sign language was from the fifth century BC, in Plato's Cratylus, where Socrates says: If we had no voice or tongue, and wanted to express things to one another, would we not try to make signs by moving our hands, head, and the rest of our body, just as dumb people do at present.

Adigun and Ajayi (2015) defined sign language as any form of visual language that requires manipulation of hand into shapes, body movement, systematic placement of hands, facial expressions in order to convey spoken words to an individual with hearing loss. Therefore, there is tendency for interruption of communication between persons with hearing impaired and those with normal hearing. Fortunately, this communication gaps are bridged by sign language interpreters (SLIs). Sign language interpreter is a professional trained personnel who facilitates communication and conveys all auditory and signed information so that both hearing and deaf students will fully interact in the society.

In 19th century, most of what one knows about historical sign language was limited to the manual alphabets (finger spelling systems) that were invented to facilitate transfer of words from a spoken to a signed language, rather than documentation of the rest of the language, however, many different sign language have developed independently throughout the world, and no true first language can be identified (Dipo, 2015).

Sign language and manual alphabet were found worldwide, and most recorded instance of sign language seem to occur in Europe in the 17th century, it was possible that popular European ideals have overshadowed much of the attention earlier signed systems may have otherwise received. It was commonly accepted, for instance, that the deaf could not be educated; when John of Beverly, Archbishop of York, taught a deaf person to speak in 685 AD, it was deemed a miracle, and was later canonized (Groce, 2015). Earlier than the 17th century, a group of deaf people may have already lived together in communities, where even in small number they may have communicated through basic sign language.

Statement of the Problem

Commented [A1]: In the text, do not use the first person "we"

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Appropriate assistive technologies play a crucial role in enhancing the learning experience of individuals with hearing impairment. Research has shown that the utilization of assistive technologies, such as video tape recording, can significantly aid students with hearing impairment in their educational journey due to the unique features it offers (Ndoh & Umbugadu, 2024). The departmental findings from 2015 to the present at FCE (Special) Oyo have highlighted that algebra, with its abstract nature, has been a challenging concept for students with hearing impairment over the past decade, resulting in a higher failure rate. Video enables students who are hard of hearing or hearing impaired (deaf) to visually comprehend the content through the use of video, captions, gestures, and lip reading. The inclusion of captions or subtitles in the video package enhances accessibility for individuals with hearing impairment (deaf), providing them with a more comprehensive understanding of the video material (Sulaiman, 2023).

Researchers like Ale and Adetula (2015) reported high level of failure rate of students in Mathematics over the years. This is connected with the poor method of teaching employed by Mathematics teachers as well as the negative attitude of students towards the concept. Mishra (2010) stated that video can be used to show practical and real life activities which can be used to capture hazardous costly experiment for presentation with repeated use. Makinde (2023) findings show that video instructional package produces better effect than the conventional method. It was also proved by Nagayama et al. (2024) that video resources are expensive to produce but is very useful where practical demonstration skills are required.

It was generally observed that failure in Mathematics of the hearing students is high while that of the hearing impaired is higher. This is because Algebra is abstract in nature and not easy for the hearing impaired students to grasp and understand without taking one step after the other. It is on this premise that this study evaluates a sign language video package in teaching algebra to students with hearing impairment.

Purpose of the Study

Specifically this study evaluates a sign language video package:

1. Determined the effectiveness of the package on the performance of students taught with the package.
2. Determined the effectiveness of the package on male and female hearing impaired students.

Research Question

This study answered the one research question:

1. What is the performance of the students after been taught with the sign language video package?

Research Hypothesis

The study tested the null hypothesis:

Ho1: There is no significant difference in the academic performance of male and female students with hearing impairment who were taught using the sign language video package.

Scope of the Study

This study focused on evaluating a video package for teaching Mathematics concept (Algebra) to College of Education students with hearing impaired in Oyo state. College of Education (Special) Oyo would be purposively sampled because of its peculiarities in South-west, Nigeria and being the only College of Special Education in Africa. Hearing impaired students from part I offering General Studies in Education (GSE) was sampled for the study. Finger spelling, Lip - reading, body gestures and captions to teach algebra was formed the contents of the video. Experts in the field of Mathematics teaching, Computer Experts and Educational Technologist were involved in the evaluation of the package being selected.

A group pre–test, post-test of research design was used to compare the performance of the hearing impaired students that were exposed to the captioned sign language video package on algebra.

Sample and Sampling Technique

Population for the study was all students of Federal College of Education (Special) Oyo. Purposively, all part 1 hearing impaired students offering courses involving mathematics were sampled for the study. In all, there were 100 students offering mathematics courses either as major or as minor. However, 26 students of Economics that were earlier sampled for the validity were exempted from the final study, in all, 74 students were engaged for the final study. All of them were harvested from the General Studies in Education (GSE) class. The area of mathematics examined was Algebra.

Research Instruments

The following research instruments were used to gather the relevant data:

The instrument was Sign Language Video Package which contains Simplification, Factorisation, Fraction and Variation (direct and inverse variation). These are the sub-titles that were treated in line with the presentation style for delivering the lecture under the normal classroom situation and the use of similar lesson note for teaching the hearing impaired students.

The second instrument was lesson notes which contains the topic, class size, duration, time allotted. Others are the behavioural objectives, which has five items and the instructional materials stated. Also previous knowledge, introduction of the sub- topic and the presentation of the topics were contained in the lesson note.

The third instrument was the achievement test in which the pre-test performance test was extracted from the Nigeria Certificate in Education (NCE I) Mathematics examination of the FCE (Special) Mathematics examination questions while the same set of questions was used for the post-test on the same set of students after the administration the of the package. The post-test items were the same used for the pre-test.

The forth instrument was three validation sheets designed by the researcher were used for experts rating. They are the Educational Technology experts, Mathematics experts and Computer experts rating sheets respectively. The Educational Technology experts rated the package using a 4-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Agree and 4=Strongly Agree). The Content Validity Index (CVI) was used to estimate the validity of the technical aspect of the video package. The other comments made by the reviewer shows that the package is original, very good, appropriate and educating. Therefore, from the overall responses from the reviewers to the items extracted from the video package by the researcher, it showed that the video package is standard, reliable and contain what it is meant to achieve.

The Mathematics expert each reviewer independently rated the relevance of each item/questions that was extracted based on video package using a 4-point Likert scale (4 = Strongly Agree, 3 = Agree, 2 = Disagree and 1 = Strongly Disagree). The Content Validity Index (CVI) was used to estimate the validity of the Mathematical content of the video package. Hence, from the overall responses, it was deduced that the content of the video package portray simplicity in Mathematics (algebra), standard and educative.

The computer experts each reviewer independently supplied response to each of the 6-item open- ended questions that was extracted based on computer programme of the video. The Content Validity Index (CVI) was used to estimate the validity of the computer aspect of the

video package. However, from the overall responses of the reviewers, it showed that the video package depicts excellent legibility, Navigation, Functionality, Sign-language Interpretation, Durability, and improvement in Stimulation all in the teaching of Mathematics concept (Algebra) to Hearing Impaired.

Validation of Research Instruments

Validation of the instrument was carried out in three phases. Phase one was the validation of the video package content on algebra by two (2) Mathematics lecturers of Federal College of Education (Special), Oyo. Consequently, the responses of the reviewers were subjected to Statistical Package for Social Sciences (SPSS 24.0) in order to establish its internal consistency and validity. The results also revealed that the Cronbach's alpha from the item-total statistics show that all 12 items (including the suggestion aspect) have internal consistency of .812 which was above .50 level of significance.

The second validation was from two Educational technology experts from the University of Ilorin. However, the responses of the reviewers were subjected to Statistical Package for Social Sciences (SPSS 24.0) in order to establish its internal consistency and validity. The results showed that the Cronbach's alpha, using the item by item analysis for all 15 items (Suggested aspect included) have internal consistency of .64 which was above .50 level of significance. The statistical analysis showed that the items under instructional package and technical aspect of the video programme has a standard internal consistency which means they measure what they were purported to measure and are really reliable.

The third phase was from two computer experts from the University of Ilorin .The responses of the reviewers were subjected to Statistical Package for Social Sciences (SPSS 24.0) in order to establish its internal consistency and validity. The findings indicated that the item by item analysis demonstrated a Cronbach's alpha of .67 for all 6 items, surpassing the standard level of significance of .50. The lesson notes used for this evaluation of the video instructional package was examined critically by the mathematics experts to ascertain its reliability and corrections made was done by the researchers accordingly.

The researcher used 26 hearing impaired students for the achievement test on algebraic expression. This was used to find the extent to which the students have understood the concepts algebra by using sign language video instructional package. The sign language video package in

this study contained all the topics under algebraic expression and was critically examined by the experts.

Reliability test was carried out at the Federal college of Education (special), Oyo, engaging 26 students of Economics who were not part of those used for the final study because FCE is the only Special Education College in South-west, Nigeria hence, no other institution could have been used. The administration of the video package was carried out twice within the interval of two weeks with the same set of respondents who were not part of the research sample and the data to be collected was subjected to item by item statistical analysis to determine the reliability index. The results for the reliability of the 10 items (Mathematical questions) generated/extracted for the video package. Using the Cronbach's alpha from the item by item analysis the results shows all 10 items (questions) have internal consistency of -.129 which was below acceptable standard of .50 level of significance. The analysis shows that some of the items (questions) are inconsistent which means they would be deleted, these were items 6, 2, 1 and 9. By these, the internal consistency of the item by item analysis increased to .56, which was acceptable,. These 4 question items were not part of the final test items administered on the target sample for the final study.

Procedure for Data Collection

Data were collected in phases. The first phase involved the collation of resources, including course content and necessary technical inputs. The second phase focused on gathering data from the pre-test. Finally, after a period of six weeks, data from the post-test were collected. Before administering the package and tests, students were given the option to voluntarily participate in the study. Their consent was obtained through a form, and all students agreed to partake in the exercises.

Data Analysis Techniques

Descriptive and inferential statistics were used to analyse both the research question and research hypothesis. Ratings of the experts for the video package as represented in research

questions 1 was analysed using descriptive statistic mean while t-test was used as analytical tool for hypothesis

Research Question 1: What is the performance of the students after being taught with the sign language video package?

Table 1:

Showing the summary of the comparison of the students' scores at the Baseline of Study Pre-test and Post-test

Questions	Baseline (Pre-test) N=72 x ± S.D	(Post-test) N=72 x ± S.D	P
Mean Q1	1.21 ±.41	1.90± .29	<.01
Mean Q2	1.11 ± .32	2.00 ± .00	<.01
Mean Q3	1.19 ± .39	1.90± .29	<.01
Mean Q4	1.00± .00	2.00± .00	<.01
Mean Q5	1.11± .11	1.90± .29	<.01
Mean Q6	1.09 ±.29	1.80± .39	<.01

KEY: Q1**:**7a-2b-3a-8b-a. **Q2**: One-third is written as? **Q3**:$\frac{3x-2}{5} + \frac{x-1}{3}$ Q4: If d inversely as t, Use the symbol$\boldsymbol{\alpha}$to show a connection between d and t. **Q5**: a+(2a-7b). **Q6**: If P varies inversely as the square of q=8, when q=4. Find q when p=32.

Table 1 revealed that there was a notable increase in mean scores from the pre-test to the post-test across all questions, suggesting that the sign language video package effectively enhanced student understanding. **Q1**: Improved from 1.21 (±0.41) to 1.90 (±0.29); **Q2**: Improved from 1.11 (±0.32) to 2.00 (±0.00); **Q3**: Improved from 1.19 (±0.39) to 1.90 (±0.29); **Q4**: Improved from 1.00 (±0.00) to 2.00 (±0.00); **Q5**: Improved from 1.11 (±0.11) to 1.90 (±0.29); and **Q6**: Improved from 1.09 (±0.29) to 1.80 (±0.39). The reduced standard deviations in the post-test scores for most questions suggest more consistent performance among students after

using the package. All questions showed p-values of <0.01, indicating statistically significant improvements in performance after the intervention.

Research Hypothesis

Ho1: There is no significant difference between the performance of male and female students with hearing impairment exposed to sign language video package.

Table 2:

Summary of t test analysis showing the influence of gender differences of the students with hearing impaired exposed to sign language video package.

Gender	N	Mean	SD	T	df	f	P
Male	36	11.22	1.61	-2.12	70	31.08	<.05
Female	36	11.81	.40				

Table 2 indicated that female students had a slightly higher mean score (11.81) compared to male students (11.22), suggesting that females performed better overall after using the sign language video package. The standard deviation for male students (1.61) was higher than that for female students (0.40), indicating greater variability in the performance of male students. The t-value of -2.12 indicates a difference in means between the two groups (male and female) students. While the p-value (<0.05) suggests that the difference is statistically significant, meaning that the null hypothesis (Ho1) can be rejected.

Discussions

The findings from Table 1 reveal a significant increase in mean scores from the pre-test to the post-test across all questions, indicating that the sign language video package effectively enhanced student understanding. The improvement in mean scores—such as Q1 from 1.21 (±0.41) to 1.90 (±0.29) and Q2 from 1.11 (±0.32) to 2.00 (±0.00)—demonstrates that students

significantly benefited from the intervention. Lower standard deviations of the post-test scores indicate that student performance became more consistent after using the package. This uniformity implies that the instructional method was effective for a broad range of students, this corroborated Makinde (2020) that observed that using flipped classroom video package enhanced students' performance and retention in secondary school mathematics. The p-values below 0.01 for all questions indicate that there is a statistically significant difference and prove that the sign language video package is an effective tool in education, according to Oyawole (2021). The obvious relationship with available literature is that Ndoh and Umbugadu, 2024, described available literature arguing for the view that education by use of visual aids and technology is particularly effective in the enhancement of learning outcomes for students with impairments in hearing. These results show that multimedia resources are therefore relevant in the teaching strategies for both comprehension and performance enhancement in different learning situations.

The findings from Table 2 show that female students had a slightly higher mean score (11.81) compared to male students (11.22), suggesting that females performed better overall after using the sign language video package. The higher standard deviation for male students (1.61) compared to female students (0.40) indicates greater variability in male performance, which may suggest less consistency in how male students benefited from the package. This is in line with the study of Makinde (2023) who observed that female students more likely to perform better than their male counterpart when subjected to video learning package.

The t-value of -2.12 signifies a measurable difference between the groups, and the p-value (<0.05) indicates that this difference is statistically significant, allowing the rejection of the null hypothesis (Ho1). This suggests that gender plays a role in how students respond to the instructional method, with female students showing more consistent improvement. This aligns with research that highlights differences in learning styles and responses to educational interventions based on gender (Nagayama et al., 2024). The use of visual aids, like sign language video packages, can enhance engagement and comprehension, particularly among female students, who may have stronger visual learning preferences (Makinde, 2023).

Conclusion

The analysis shows a significant difference in performance between male and female students, with female students performing better. The low p-value (<0.05) confirms that this difference is statistically significant, indicating that gender had a significant impact on the performance of students exposed to the sign language video package. This suggests that the package may be more effective for female students in this context.

The results also indicated that the sign language video package was used for students with hearing impaired and was found effective for learning algebra concepts. In this study hearing impaired female students perform better than the male hearing impaired students. The findings showed that there was a significant difference in the performance of male and female in the study.

DSLVP therefore, brings about effective learning of algebra concepts. This is an indication that it is an interesting and alternative for individualized learning. Hearing impaired students were able to solve problems independently without the help of any instructors. It is hoped that the utilization of this instructional package for learning algebra concepts in Nigeria College of Education (NCE) will allow better understanding of the concepts among hearing impaired students and improve students' performance in general.

Recommendations

The following recommendations were made based on the findings of this study.

1. Video instructional package can stand as a surrogate teacher in the classroom.

2. The study would make known the unique role of visual in education of learners with special challenges and raise hope as well as enable learners with hearing impairment to develop positive attitude to learning.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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