

Effects of Multimedia Integrated Instruction on Students' Acquisition of Science Process Skills in Basic Science

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Abstract

The study investigated the effects of multimedia integrated instruction (MII) on basic science students' acquisition of science process skills in Anambra state. The study adopted the non-equivalent control group design. Two research questions and three hypotheses guided the study. 1,093 JSS2 students (542 males and 551 females) formed the population of the study. Simple random sampling technique was used to select two schools from which 98 students (45 males and 53 females) formed the sample size. Data for the study was collected using the instrument tagged "Science Process Skills Acquisition Test" (SPSAT) with reliability coefficient of 0.79 established using Kuder-Richardson formula 20 (KR-20). Mean and standard deviation were used to answer the research questions while analysis of co-variance (ANCOVA) was used to test the null hypotheses. The results revealed that MII is more effective in fostering basic science students' acquisition of Science Process Skills than the conventional method irrespective of gender. Based on the results of the study, it was recommended that teachers should adopt MII for teaching basic science since it has proved to be effective in fostering the acquisition of science process skills.

Keywords: Basic science, Gender, Multimedia integrated instruction, Science Process Skills

Introduction

Basic science (formerly known as integrated science) is the foundational subject which every child must be introduced to at the primary and junior secondary school levels in Nigeria. This subject forms the basis of every core science subject offered by students in the senior secondary schools. It is therefore imperative that every student is offered the best of basic science education to facilitate their interest in sciences. For basic science to achieve this, it is necessary that the purpose of science education be achieved. The purpose of science education is to enable individuals use process skills to define the problems around them, observe, analyze, hypothesize, experiment, conclude, generalize, and to apply the information they have gathered in solving problems encountered in their day to day activities (Mbonu, 2018). Science process skills include skills that every individual could use in each step of his/her daily life by being scientifically literate and increasing the quality and standard of life by comprehending the nature of science. These skills affect the personal, social, and global lives of individuals (Huppert, Lomask & Lazarorcitz, 2002). Science process skills were popularized by the curriculum project: Science- A Process Approach (SAPA) developed by The American Association for the Development of Science in December 1971. These skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists. SAPA grouped process skills into two types, basic and integrated. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills.

The basic (simpler) science process skills include the following: observing, inferring, measuring, communicating, classifying and predicting. The Integrated (more complex) Science Process Skills include: controlling variables, defining operationally, formulating hypothesis, interpreting data, experimenting and formulating models. Brief descriptions of the features of the afore-mentioned basic science process skills include; Observing: This skill makes use of all five senses in taking information about all things

around us. The skill of observing can be developed in children by giving them practice that involves using their senses. The indicators of the acquisition of this skill include; use of senses in identifying the similarities and differences in nature, noticing details that are relevant to any investigation, recognizing the order in which sequential events occur and looking for patterns that exist in observed phenomena. The skill of Predicting involves a forecast of what will certainly happen. A prediction should be followed by a written or oral explanation to clarifying ideas and reveals any misconceptions and missing information. The behavior indicators of this skill include ability to detect trend in data and be able to use these trends to predict things and recognizing and using arguments, reasons or principles to justify a prediction.

Communicating skills involves using the written and spoken words graphs, drawings, diagrams or tables to transmit information or ideas to others. In order to reflect the true nature of science, ideas must be shared. This skill requires time and practice to develop. The behavior indicators of its acquisition are accurate graphical representation of information, ability to follow instruction and ability to report experiment in concise and meaningful way. The skill of Classifying involves grouping or ordering objects or events into categories based on their properties or criteria. During this process, things or events are organized, categorized, and grouped, based on observed or measured property to form an easily recognized pattern.

Inferring involves making an opinion from fact. This skill means drawing conclusions or deducing. For example, if a balloon is found floating in the sky, it can be deduced that the balloon is filled with air. It may be regarded as a basis for judgment. The behavior indicators are: the ability of the individual to put various pieces of information together and draw generalization from the body of the data and ability to identify factors most likely to have caused a given change in a system. Measuring as a skill involves using standard and non-standard measures or estimates to describe the dimensions of an object or event.

Realizing the importance of science process skills in solving scientific problems, the Federal Republic of Nigeria in its National Policy on Education (2013) stated that education should aim at helping the child in the acquisition of appropriate skills, abilities and competencies, both mental and physical as equipment for individual to live in and contribute to the development of the society (FRN, 2013). To achieve these goals, basic science must be taught to foster process skills acquisition.

According to the performance reports from the Examination Development Centre (EDC) in Anambra state 2012-2019, basic science students still perform below average in both internal and external examinations. Students have been reported to have more passes and fails than credits and distinctions in basic science. According to the performance reports, students' persistent below average achievement in basic science could be as a result of lack of understanding of the questions, inability to make proper observations, poor teaching methods and strategies, non-possession of process skills by the students and the inability of the teachers to introduce innovative teaching methods that will foster the acquisition of these skills (EDC, 2019). It has been advised that a more effective and innovative approach to the teaching and learning of basic science be introduced (Mbonu & Okoli, 2019 and Mbonu, 2018). According to Oludipe (2012), basic science teachers' use of mostly teacher-centered methods instead of innovative and student-centered teaching methods has continued to hinder the acquisition of science process skills among basic science students. The most widely used teacher-centered method of instruction is the conventional method.

The conventional method is any teaching method that is teacher-centered and usually not innovative. This method entails the teacher being the sole provider of knowledge. It is

employed so much in teaching probably because it enables the teacher to cover large volumes of content in a single lesson and also teach a large number of students at the same time but it has not always encouraged acquisition of science process skills by learners (Oludipe, 2012). This is probably because it makes the students passive in the classroom instead of stimulating their senses or exposing the learners to hands-on scientific activities.

Teachers' inability to let go of the conventional method and use more of the innovative and student-centered teaching methods may have prevented students from understanding the subject especially the concepts that appear abstract. It is imperative therefore that a more effective and innovative approach to the teaching and learning of science subjects in general and basic science in particular be introduced. The researcher advocates the integration of innovative teaching methods in the teaching of basic science to find out whether students' acquisition of science process skills will improve. An example of such innovative teaching methods is the use of multimedia. Multimedia in education are those resources used in instruction that include a variety of media such as graphics, video, animation, image and sound in addition to textual information. With these resources, learners are provided with the rich learning experiences that draw their minds near to some laboratory activities, demonstrations and other hands-on activities in a science classroom. In this type of instruction, the teacher employs the use of various multimedia technological tools adaptable to educational purposes in the teaching and learning process.

Felder (2014) established that students respond well to the use of images to stimulate their interests in a subject. From the study, Felder also found that 65% of the population preferred the use of visual images such as photographs, maps, paintings, graphs, charts, drawings in learning; and that 30% of the population prefers to receive information in an auditory manner while the remaining 5% of the population preferred kinesthetic approach which involves doing things as a way of learning new information. The kinesthetic approach includes participating in laboratory activities, demonstrations, and various kinds of simulations. However, it is rare to find all three of these approaches to learning incorporated into a class. While it may seem impossible to do this, it can be done through thoughtful planning and preparation of a multimedia integrated form of instruction.

Multimedia integrated instruction adds to learning experiences because concepts are easier to present and comprehend when the words are complemented with images and animations (Ogunbote & Adesoye, 2006). It provides different stimuli in its presentation which include a number of elements some of which are texts, sound & music, graphics, animations and still pictures (Aloraini, 2005). According to Vebrianto and Osman (2011), Serin (2011) and Satyaprakasha and Behera (2014), students taught with multimedia based instruction strategies showed a statistically significant increase in their process skills acquisition than those taught with the Conventional method. The power of multimedia lies in the fact that it is multi-sensory, stimulating and appealing to the many senses of the learners. The strengths of multimedia learning include; flexibility of time and space- the multimedia instruction classroom allows students to suspend and revisit study materials at their convenience and within a flexible time frame (Hughes, McLeod, Brown, Maeda, & Choi, 2007); a multimedia application like the animation or video simulations can also be applied for practice of potentially dangerous practical experiments; multimedia instruction combines concrete ideas and abstractions, with teaching conducted through image presentation texts, numbers, and audio presentations in sequence; the attractive live designs and audio and flash effects included in a multimedia instruction can attract and encourage students' attention; using different presentations like video clips along with maps or other kinds of presentations help to get the information closer to reality. Adding sounds make the idea clearer and it attracts the attention of the learners (Aloraini, 2005). It is clear that the role of multimedia in the

education process is potentially significant. In order to gain maximum benefit from the use of this technology, it is important that the advantages are used as a baseline to developing an appropriate lesson plan. It has been observed that the average school child whether boy or girl spends time watching the television and playing video (phone) games. These media tools like the videos and animations can be made available for replay at home and can serve as attractions to the child irrespective of gender.

Gender is a socially ascribed attribute which differentiates males from females (Elitzen, 2006). Gender is nevertheless an issue of concern to science educators and researchers especially as some courses have been ascribed to be mainly for the male students or female students and vice versa especially in Nigeria. Many studies have shown that boys' attitude toward sciences were more significantly positive than that of girls, especially boys interest in chemistry and earth science (Donald, 2000). Nwosu (2001) in a study reveals that exposure to science process skills based learning involving activities for both males and females yield a more effective learning irrespective of gender. It is in line with Yolooye (2004), Nworgu (2005) and Usman (2010) who share the opinion that if males and females are given equal opportunity, they will perform equally well. Several studies have been carried out in other sciences to determine the effects of multimedia in instruction. This present study however is carried out in basic science and seeks to find out if multimedia integrated instruction can foster the acquisition of science process skills and if this acquisition of science process skills is influenced by gender.

Statement of the Problem

One of the objectives of the teaching and learning of basic science in secondary schools is to promote an understanding of basic science concepts being taught with a view to applying such knowledge in solutions to real life problems as well as enhance acquisition of science process skills. These aims and objectives cannot be realized except through the effective effort of the classroom teacher. To achieve the goals set by the Federal Republic of Nigeria concerning basic science teaching, it is necessary that a well-designed teaching strategy which will provide the sort of learning necessary for the students to develop science process skills be employed since reviewed literature has shown that the traditional (conventional) method hasn't been very effective. This study therefore sought to find out if multimedia integrated instruction can foster students' acquisition of science process skills in basic science.

Purpose of the Study

The purpose of this study was to determine the effects of multimedia integrated instruction on basic science students' achievement. Specifically, the study determined:

- i. the effect of multimedia integrated instruction (MII) and conventional method (CM) on students' acquisition of science process skills in basic science
- ii. the influence of gender on students' acquisition of science process skills in basic science
- iii. the interaction effect of teaching methods and gender on students' science process skills acquisition in basic science.

Research Questions

The research questions posed for this study were

1. What is the difference in the mean science process skills acquisition test (SPSAT) of students' taught basic science using multimedia integrated instruction (MII) and conventional method (CM)?

2. What is the influence of gender on the mean science process skills acquisition test (SPSAT) of the basic science students' taught using multimedia integrated instruction (MII)?

Research Hypotheses

The following null hypotheses were formulated and tested at .05 level of significance

- H₀₁: There is no significant difference in the mean science process skills acquisition test (SPSAT) scores of students' taught basic science using Multimedia integrated instruction (MII) and those taught using conventional method (CM).
- H₀₂: There is no significant gender influence on the mean science process skills acquisition test (SPSAT) scores of basic science students' taught using Multimedia integrated instruction (MII).
- H₀₃: There is no interaction of teaching methods and gender on students' mean science process skills acquisition test (SPSAT) scores in basic science.

Method

The non-equivalent control group design was used in this study. This design was used because the study used intact classes so subjects were not randomized. The population of the study comprised all 1,093 JSS2 students (542 males and 551 females) from the 15 co-educational secondary schools in Awka south Local Government Area in Anambra state, Nigeria. Simple random sampling was used to select 2 out of the 15 schools. The sample size of the study is made up of 98 JSSII students (45 males and 53 females) from two intact classes sampled from 2 selected junior secondary schools. These intact classes served as the experimental and control groups for the study respectively.

One instrument titled Science Process Skills Acquisition Test (SPSAT) was used for the study. The instrument consisted of two sections namely A & B. Section A was for the personal information of the students while section B was for the purpose of evaluating the students' acquisition of science process skills. The instrument has a reliability coefficient of 0.79 which was ascertained using Kuder Richardson's Formula 20 (KR-20). Science process skills acquisition test (SPSAT) contained 20 multiple choice question items which were constructed by the researchers based on the concepts of the molecular structures of solids, liquids and gases, evaporation and boiling, heat transfer through conduction, convection and radiation. It was used to measure students' science process skills acquisition in both the experimental and control groups.

The Science Process Skills Achievement Test (SPSAT) was administered on the students in both the experimental and control groups by their regular classroom teachers (Pre-testing) before the commencement of treatment and no feedback was given to the students on their pretest achievement. The classroom teacher for the experimental group was trained for three days on how to use the multimedia integrated instruction materials including the lesson plan while the classroom teacher for the control group was asked to teach as she normally would. The experimental group was taught the selected basic science concepts using multimedia integrated instruction while the control group was taught the same lesson concepts using only the conventional/traditional method of instruction. After five weeks of teaching and the revision period, the same instrument (SPSAT) was reshuffled and re-administered to the same students in their classrooms in the sixth week (Post-testing). The research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of covariance (ANCOVA) at 0.05 level of significance.

Results

Research Question 1: What is the difference in the mean science process skills acquisition scores of students' taught basic science using Multimedia integrated instruction (MII) and conventional method (CM)?

Table 1: Mean science process skills acquisition test Scores and standard deviation of Students taught basic science using multimedia integrated instruction (MII) and Conventional Method (CM)

Source of Variation	N	Pretest Mean	Posttest		Gained Mean	Decision
			Mean	SD		
MII	48	22.19	73.96	3.57	51.77	Effective
CM	50	18.40	48.80	2.78	30.40	

Table 1 reveals that the students taught basic science using MII had pretest mean science process skill acquisition score of 22.19 and posttest mean science process skill acquisition score of 73.96 with gained mean achievement score of 51.77 and standard deviation score of 3.57 while those taught using conventional method had pretest mean score of 18.40 and posttest mean score of 48.80 with gained mean of 30.40 and standard deviation score of 2.78. With gained mean score of 51.77, MII is effective in enhancing students' science process skill acquisition in basic science.

Research Question 2: What is the influence of gender on the mean science process skills acquisition (SPSAT) scores of basic science students' taught using multimedia integrated instruction (MII)?

Table 2: Mean science process skills acquisition test scores and standard deviation of Male and Female Basic Science Students exposed to Multimedia Integrated Instruction (MII)

Gender	N	Pretest Mean	Posttest		Gained Mean	Decision
			Mean	SD		
Male	22	24.55	74.77	3.61	50.22	More effective
Female	26	20.19	73.27	3.45	53.08	

Table 2 indicates that male students have pre-test mean score of 24.55, post-test mean score of 74.77, post-test standard deviation score of 3.61 and gained mean score of 50.22 while female students have pre-test mean score of 20.19, post-test mean score of 73.27, post-test standard deviation score of 3.45 and a gained mean score of 53.08. MII therefore was more effective for female students with higher gained mean score of 53.08.

Testing the Null Hypotheses

H₀₁: There is no significant difference in the mean SPSAT scores of students' taught basic science using Multimedia integrated instruction (MII) and those taught using conventional method (CM).

Table 3: Analysis of covariance (ANCOVA) of basic science students' mean science process skills acquisition test scores by teaching methods

Source	SS	Df	MS	F	P-value	Decision
Corrected Model	15503.993 ^a	2	7751.996			
Intercept	44726.752	1	44726.752			
Pretest	3.379	1	3.379			

Methods	14488.730	1	14488.730	1415.296	.000	S
Error	972.538	95	10.237			
Total	382600.000	98				
Corrected Total	16476.531	97				

Table 3 shows that at 0.05 level of significance, 1df numerator and 47df denominator, the calculated F is 1415.296 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus, effect of MII on secondary school students' science process skills acquisition in basic science differs significantly when compared with that of Conventional Method (CM) using their posttest mean scores.

H₀₂: There is no significant gender influence on the mean science process skills acquisition test (SPSAT) scores of basic science students' taught using Multimedia integrated instruction (MII).

Table 4: Analysis of covariance of the influence of gender on basic science students' science process skills acquisition test scores

Source	SS	Df	MS	F	P-value	Decision
Corrected Model	32.654 ^a	2	16.327			
Intercept	28581.764	1	28581.764			
Pretest	5.717	1	5.717			
Methods	19.146	1	19.146	1.524	.223	NS
Error	565.262	45	12.561			
Total	263150.000	48				
Corrected Total	597.917	47				

Table 4 shows that at 0.05 level of significance, 1df numerator and 47df denominator, the calculated F is 1.524 with P-value of .223 which is greater than 0.05. Therefore, the null hypothesis is not rejected. Thus, effectiveness of Multimedia Integrated Instruction (MII) on male secondary school students' science process skills acquisition in basic science does not differ significantly when compared with that of female students using their posttest mean scores.

H₀₃: There is no interaction of teaching methods and gender on students' mean science process skills acquisition test (SPSAT) scores in basic science.

Table 5: ANCOVA on interaction effects of Gender and teaching methods on secondary school students' Science Process Skills Acquisition in basic science

Source	SS	Df	MS	F	P-value	Decision
Corrected Model	15528.304 ^a	4	3882.076			
Intercept	39710.499	1	39710.499			
Pretest	.530	1	.530			
Method	14158.447	1	14158.447			
Gender	12.711	1	12.711			
Method * Gender	11.023	1	11.023	1.081	.301	NS
Error	948.227	93	10.196			
Total	382600.000	98				
Corrected Total	16476.531	97				

Table 5 shows that at 0.05 level of significance, 1df numerator and 97df denominator, the calculated F is 1.081 with P-value of .301 which is greater than 0.05. Therefore, the null

hypothesis six is not rejected. Thus, there is no significant interaction of teaching methods and gender on students' science process skills acquisition in basic science.

Discussion

The findings of this study show that students taught basic science using multimedia integrated instruction achieved a higher mean science process skill acquisition (SPSAT) score than students taught using the Conventional method. This shows that MII is more effective in fostering acquisition of science process skills in basic science students than the conventional method. The significant increase in the science process skills acquisition scores of students in the experimental group could be as a result of the problem-solving transfer effect which multimedia integrated instruction is known for. This result is in tandem with that of Vebrianto and Osman (2011), Serin (2011), Satyaprakasha & Behera (2014) that found out that students taught with multimedia-based instruction strategies showed a statistically significant increase in their process skills acquisition than those taught with the Conventional method. This significant increase could be attributed to the contiguity effect of multimedia-based instructional strategies.

The findings of this study also reveal that there is no significant difference between the mean science process skills acquisition (SPSAT) scores of male and female students taught basic science using multimedia integrated instruction (MII). It also revealed that male and female students taught basic science with multimedia integrated instruction had an increase in their gained mean scores. Although the MII was more effective in enhancing the acquisition of science process skills of female students more than their male counterparts, the male students' achievement in basic science does not differ significantly when compared with that of the female. This result shows that MII does not favor any gender over the other. It enhanced the acquisition of science process skills of both male and female students without bias. This finding is in tandem with that of Yoloeye (2004), Nworgu (2005) and Usman (2010) who share the opinion that if males and females are given equal opportunity, they will perform equally well. This non-significant difference in the acquisition of science process skills of both male and female students in the experimental group might be attributed to the fact that multimedia integrated instruction is gender friendly. It appealed to the senses of both male and female students and encouraged acquisition of problem-solving skills.

The interaction effect between teaching methods and gender on students' science process skills acquisition (SPSAT) in basic science is not significant. This implies that the effects of the instructional techniques were consistent across gender.

Conclusion

Basic science which is the foundational science subject which learners are first introduced to requires students' undivided attention and active participation. It also requires a teaching method that will not only capture the attention of the learners but will also foster the acquisition of the science process skills. Acquisition of these science process skills is the first step towards becoming a scientist.

This study has confirmed this fact by revealing that basic science students taught with multimedia integrated instruction attained high significant mean science process skills acquisition test scores than their counterparts taught with the Conventional method. Therefore the use of multimedia integrated instruction fostered students' acquisition of science process skills better than the use of conventional teaching method.

The findings also revealed that gender did not significantly influence the acquisition of science process skills of students taught basic science using multimedia integrated instruction. This implies that multimedia integrated instruction is not gender biased.

The findings also revealed that there were no significant interaction effects between teaching methods and gender on students' science process skills acquisition in basic science.

Recommendations

1. Basic science teachers should adopt multimedia integrated instruction as one of the instructional strategies for teaching basic science to reduce the use of the conventional method which has been found to be ineffective in fostering the acquisition of science process skills in basic science.
2. In-service and pre-service training programs for basic science teachers in form of seminars, workshops, symposia and conferences should be organized by government and education stakeholders and should focus more on how to use innovative teaching strategies like multimedia integrated instruction.

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