

Effects of Improvised Materials on Students' Achievement and Retention of the Concept of Radioactivity

(Pp. 342-353)

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Abstract

This paper is an empirical study aimed at finding out the effect of improvised material on students' academic achievement and retention on the concept of radioactivity. The study adopted the pretest post test non-equivalent control group design and was carried out in Calabar Education Zone, Cross River State Nigeria. A total of two hundred and forty seven (247) Senior Secondary School III Physics students took part in the study. The Analysis of Covariance (ANCOVA), Multiple Analysis (MCA) and t-test were used to analyze the data. The results of the study showed a significant difference in academic achievement between the experimental and control groups in favour of the experimental group, a significant difference in the mean

academic achievement between the male and the female students in favour of the male students and a significant difference in the retention between the experimental and control groups in favour of the experimental group. The study recommend among others the use of improvised material in the teaching of physics where the accredited ones are lacking.

Introduction

The concept of improvisation in science teaching has come to stay with us. According to Balogun (1982), no matter how generous and rich an education authority might be, they are generally not always in a position to provide their schools with all they need.

Improvisation could be seen as the act of providing teaching materials from our locality when there is shortage or lack of the standard ones. Eshiet (1996) defined improvisation as the sourcing, selection, deployment of relevant instructional elements of teaching/learning process in the absence or shortage of the accredited teaching/learning element for a meaningful realization of specified educational goals and objectives.

In the science class, teaching aids are needed to supplement the teacher's oral explanation with the students' visible experiences. This is why Abdullahi (1982) stated that scientific materials used in teaching enable the students to become actively involved intellectually, perceptually and physically in the learning process. However, for an improvised material to be valid, the material should provide the desired results expected, improve the lesson effectiveness and reduce to minimum the risks associated with the usage of the equipment. The reduction in the risk of usage is a good justification for this improvisation because of its harmless nature in the study of radioactivity.

Radioactivity is a concept in the Senior Secondary School Syllabus taught under atomic structure. This concept has never been set in practical in the Senior School Certificate Examination in Nigeria. This is because the equipment for the experimental set-up is absolutely lacking at this level. This is why this improvisation is very necessary.

The rate of decay of radioactive substance depends on the nature of the substance and the mass of the substance present. Thus any experiment in which the loss of material depends on the quantity present can be used as an analogue experiment to describe radioactive decay. In this study, the analogue becomes closer when large number of dice are used and hence the random nature of the disintegration is simulated.

Statement of the Problem

The concept of radioactivity is abstract in nature. The hazardous nature of the radioactive substance makes matter worse. The equipment for the study of radioactivity at the Secondary School level in Nigeria is absolute lacking, practically oriented classes are expected to enhance better understanding of the learned concept and thus improve students' academic achievement. The studies on the practical teaching of the concept of radioactivity in Nigeria are rare. This study is undertaken to fill these gaps. The problem of this study therefore is that students and teachers see this concept as a difficult one – difficult to teach and to learn this is usually attributed to lack of instructional aids for demonstration. The researchers want to see the effect of improvised materials on students' learning

Purpose of the Study

The purposes of this study include:

1. To investigate the effect of improvised material on Secondary School Students' achievement of the concept of radioactivity.
2. To determine whether there is gender disparity in achievement when the concept of radioactivity is taught with improvised material.
3. To determine the effect of improvised material on the students' retention of the concept of radioactivity.

Hypotheses

The following null hypotheses were formulated and tested at an alpha level of 0.05.

- HO₁:** There is no statistically significant difference in the mean achievement scores between students taught radioactivity with improvised material and those taught without improvised material.
- HO₂:** There is no statistically significant difference in the mean achievement scores between male and female students taught radioactivity with improvised material and those taught without improvised material.
- HO₃:** There is no statistically significant difference in the mean retention scores between students taught radioactivity with improvised material and those taught without improvise material.

Methodology

The study adopted the quasi experimental research design. Specifically, the pre-test post test non-equivalent control group design was used.

The population for the study consisted of all the SS III Physics students in the Calabar Education Zone of Cross River State. A total of two hundred and forty seven (247) physics students took part in the study. The simple random sampling technique was used to select eight schools from four out of the six Local Government Areas in the Zone. Four schools were assigned the experimental group while the other four were assigned to the control group. The experimental group was one hundred and seventy seven (77 males and 50 females) while the control group was one hundred and twenty (67 males and 53 females). In each of the schools selected, the intact class was used.

The instrument for data collection is a Physics Achievement Test. The instrument is a 20 item multiple choice questions with options A-D. Each correct answer attracted one mark while each wrong answer attracted a zero score.

The instrument was face validated by three experts, two in Physics Education and one in measurement evaluation. The content validation was ensured using the test blue print. The reliability of the instrument was obtained by trial testing the instrument. The data obtained was analyzed using the Kuder-Richardson formula 20 and a reliability index of 0.78 was obtained.

Theory

The improvised material consisted of 350 dice. This represents the quantity of the material present at the initial time (N_0). The dice are put in a beaker and thrown into a large tray and those with the side "six" facing upwards are removed and stored in a separate container. The remaining dice are collected and throw again. The dice that has the face "six" facing upwards are removed once again. This process is repeated until few dice are left. During each throw the quantity of dice left is determined and a table of the nature shown below is made.

No. of Throw (n)	Total No. of Sixes thrown (x)	No. of dice to start with (N_0)	$(N_0 - x) = N$	$\log_{10} N$

Here, the number of sixes facing upwards will to a large extent depend on the number of dice present. The half life here is an analogue of the half of the dice remaining after 'n' number of throws.

By plotting a graph of N against n, a decay curve is obtained. Also by plotting the graph of $\text{Log}_{10}N$ against n a straight line graph is formed.

$$\text{Log}_{10}N = \frac{-\lambda.n}{2.303} + \text{Log}_{10}N_0 \text{ is obtained}$$

From here the decay constant and the half life could be calculated.

Research Procedure

In order to account for initial differences among the groups, pretest was administered to the two groups, the results obtained were used as covariate in the final analysis. Also to control the teacher variable, both groups were taught by research assistants who were the physics teachers in the selected schools. The research assistants were properly trained on the use of the improvised material.

The experimental group was taught the concept of radioactivity using the improvised material while the control group was taught without the improvised material. After the completion of the teaching, post test was administered to both groups. Two weeks later, the retention test was administered to both groups. The results of the experiment are shown below.

Results

The results are presented hypothesis – by – hypothesis. The statistical analysis used was the Analysis of Covariance (ANCOVA). Multiple Classification Analysis (MCA) and t-test. The hypotheses were tested at 0.05 level of significance.

Hypothesis One

There is no statistically significant difference in the mean achievement scores between students taught radioactivity with improvised material and those taught without improvised material.

The analysis in Table 1 shows that there is significant difference in achievement between students taught radioactivity with improvised material and those taught radioactivity without improvised material.

Consequent upon the existence of a significant difference between the experimental and the control groups, it is necessary to carryout a post hoc Analysis using the Multiple Classification Analysis (MCA) to determine the specific gain in the achievement of the students by each treatment level.

The experimental group had an adjusted mean of 16.36 while the control group had an adjusted mean of 10.83. This implies that the experimental group performed better than the control group. It also show that about 67.79% variations of students performance may be attributable to the use of improvise materials.

Hypothesis Two

There is no statistically significant difference in the mean achievement scores between male and female students taught radioactivity with improvised material and those taught without improvised material.

The calculator F-ratio under gender is 13.11 while the critical value is 6.76. Since the calculated F-value is greater than the critical value, there exists a significant difference between the mean achievements of male and female students. Hence, the null hypothesis which states that there is no statistically significant difference in the mean achievement scores between male and female students taught radioactivity with improvised material and those taught without improvised material is rejected.

Since there is a significant difference in the mean achievement between the male and female students, it is necessary to carry out post hoc Analysis using the MCA to determine which gender and the improvised material is in favour of.

From table 4, the male students have an adjusted mean of 15.86 while the female students have an adjusted mean of 11.79. This implies that the improvised material favours the males students than their female counterpart. Also with multiple regression squared index 0.10, it implies that 32% of the total variance in the performance of students in Physics is attributed to the joint effect of improvised material and gender.

Hypothesis 3 (HO₃)

There is no statistically significant difference in the mean retention scores between students taught radioactivity with improvised material and those taught without improvised material.

Table 5: Independent T-test Analysis of the Retention Test of Students taught Radioactivity with and Without Improvised Materials

Group	N		S.D.	Df	t.cal	t-crit	Decision
Experimental	127	15.75	3.55	245	12.16	1.96	*Significant
Control	120	11.25	2.16				

*Significant at 0.05 alpha level

In table 5, the calculated t-value is higher than the critical value at 0.05 alpha level. Hence the null hypothesis which states that there is no statistically significant difference in the mean retention scores between students taught radioactivity with improvised material and those taught without improvised material is rejected. This implies that improvised material aids the retention of the concept of radioactivity.

Discussion

The study was designed to find out the effect of improvised material on the academic achievement and retention of the concept of radioactivity. The findings of this study showed that there exist a statistically significant difference between students taught radioactivity with improvised material and those taught without improvised material. The success of the experimental group is due to the fact that the improvised material provided the students with concrete experience which they need in order to develop their intellect.

The above finding is in line with the findings of Folonunso and Nwosu (2006), Akinbobola (2007) and Ubana (2009) in which the experimental group taught with improvised material achieved higher than the control group. It is observed that the use of improvised materials for teaching if carefully and properly planned enhances teaching and learning of science. It makes learning of science interesting, motivating, less boring and enjoyable to the students. Adeyegbe (1993) and Igwe (1990) linked the low achievement trend in the sciences to non-availability of instructional materials in schools, thus the need for improvisation. Also Achimugu (1995), Oladele and Lasisi (2006) asserted that students comprehend and remember better when teaching materials are improvised. The task before the teacher therefore is to find a method of communicating and sharing his knowledge with the students in such a way that they can understand scientific concepts and make them less abstract. It is the believe that abstract ideas like

radioactivity could be made less abstract to students through the use of improvisation. The inquiry, curiosity, creativity and productive application of students' intellectual could be widened through improvisation (Adebimpe, 1997).

On the achievement between male and female students, the results showed that female students achieved higher than their male counterparts. The higher achievement of the male could be due to the fact the improvised material provided higher understanding, increase in motivation and the development of positive attitude toward the concept of radioactivity on the male students than their female counterparts. The findings of this study are in line with that of Akinsola and Igwe (2002) that obtained significant difference between male and female students after treatment.

This finding, however, is in contrast with that of Nsofor (2001), Symonds (2001), Mommoh-Olle (1997), Onwioduokit and Akinbobola (2005), that found no significant difference in achievement between male and female students after treatment. They observed that both male and female students could do well in school when exposed to similar learning conditions. Gender therefore is not a significant factor in academic achievement in science (Ivowi, 1999) and any difference in intellectual ability between male and female students could probably be attributed to differences in socialization.

The result of hypothesis three showed that there was significant difference in the retentive abilities of the experimental groups. This could be attributed to the fact that the improvised material provided visual and mental pictures in the cognitive structures of the students in the experimental group. Their interaction with the improvised material led to higher motivation and thus higher achievement. Ubana (2009) stated that scientific concepts are retained better and learning tend to become more meaningful and interesting when learning materials are used. Dogara and Ahmadu (2000) defined learning materials as any thing that helps to bring about success in the classroom.

The findings of this study is in agreement with the findings of Orji (2000) that obtained a result in which the experimental group performed better than the control group in the retention test. The improvised material thus seemed to make students to remember conceptual ideas more than no material.

Recommendations

Based on the findings of the study, the following recommendations are made:-

1. Physics teacher should adopt the use of improvisation to complement the standard/manufactured materials in the teaching of physics.
2. Students should be encouraged with the help of the teacher to assemble locally made material resources which should be used in the teaching of physics.
3. Government at all tiers, should assist in the supply of those materials that could not be locally produced. This will help to reduce the abstract nature of the subject.
4. Regular workshops should be organized for serving teachers to broaden their knowledge on improvisation. Such workshops should be able to make the physics teacher resourceful in knowing where and how he/she can obtain materials for improvisation to suit the concept in question.

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Table 1: Analysis of Covariance (ANCOVA) of Posttest Scores of Students Taught with Improvised Material and those taught without Improvised Material

Source of Variation	Sum of Squares	Df	Mean Squares	F	Sig. of F
Covariates	194.41	1	194.41	5.87	0.017
Main Effects	3987.34	1	3987.34	120.34	0.000*
Explained	4181.74	2	2090.87	63.10	0.000
Residual	4936.97	244	20.23		
Total	9118.71	246	37.07		

*Significantly at P < 0.05 alpha level

Table 2: Analysis of Covariance (ANCOVA) Results of Male and Female Students taught Radioactivity with Improvised Material and those taught without Improvised Material

Source of Variation	Sum of Squares	Df	Mean Squares	F	Sig. of F
Covariates	194.41	1	194.41	3.53	0.062
Main Effects	721.61	1	721.61	13.11	0.000*
Explained	916.02	2	458.01	8.32	0.000
Residual	8202.69	244	23.62		
Total	9118.71	246	37.07		

*Significant at 0.05 alpha level

**Table 3: Multiple Classification Analysis for Treatment
Grand Mean 13.50**

Variable + Category	N	Unadjsuted Dev'n	Eta	Adjusted for Independent + Covariate Dev'n	Beta
Treatment					
1. Improvised Material	127	2.45	0.66	2.86	
2. No improvised material	120	-2.70		2.67	0.66
Multiple R Squared					0.459
Multiple R					0.677

**Table 4: Multiple Classification Analysis of Gender
Grand Mean 13.50**

Variable + Category	N	Unadjsuted Dev'n	Eta	Adjusted for Independent + Covariate Dev'n	Beta
Treatment					
1. Male	144	2.28	0.27	2.36	0.28
2. Female	103	-1.66		-1.71	
Multiple R Squared					0.10
Multiple R					0.32