EFFECT OF IMPROVISED AND STANDARD INSTRUCTIONAL MATERIALS ON STUDENTS ACHIEVEMENT IN CHEMISTRY IN SECONDARY SCHOOLS

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ABSTRACT

This study investigated the effects of improvised and standard instructional materials on students' academic achievement in chemistry at the secondary school level in Ebonyi State of Nigeria. Three research questions and three hypotheses guided the study. Experimental research design was adopted in the study. The population of the study was made up of all the chemistry students in the six randomly selected secondary schools in Ebonyi State. The sample size was made up of 120 SS II chemistry students. The instrument used for data collection was the Chemistry Achievement Test (CAT) constructed by the researcher and validated by 3 experts, one from measurement and evaluation and 2 from chemistry Education. The instrument was tested for internal consistency using Pearson product moment; reliability coefficient of 0.89 was obtained. The high value shows that the instrument was reliable. The data collected using the CAT instrument was analyzed using mean and standard deviation in answering the 3 research questions. Analysis of covariance (ANCOVA) at an alpha level 0.05 was used in testing the hypotheses that guided the study. The result of the study indicated that those students taught chemistry using improvised materials performed better than those taught without them. Based on the findings, it was recommended that the state and federal government and other stakeholders in Education

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should help in training and re-training of science (chemistry) teachers by organizing, conferences, seminars and workshops for both the old and newly recruited science teachers.

Introduction

Science according to Oxford Dictionary Sixth Edition, 2005 is the concerted human effort to understand better the history of the natural world and how such natural phenomena work, with observable physical evidence as the basis of that understanding which is done through observation and experimentation. Omiko (2015) sees science as body of knowledge obtained through experimentation and observation of the daily natural phenomenon. Igwe (2003) sees science as "knowledge attained through the study of the operation of general laws of nature, especially that knowledge which is obtained, tested, approved and accepted through scientific method.

There are basically three subjects that make up science which are studied at the secondary school level: they are Biology, chemistry and Physics. Chemistry as one of the core science subjects is the foundation upon which the present day's technological breakthrough and scientific concept is built. Thus, chemistry is the branch of science that deals with the study of matter, identification of the substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine, and change as well as the use of processes to form new substance, (Reld and Shah, 2007). It is often called central science, because of its knowledge which is essential to the students of other related field of studies as; biology, geology, physics etc. Although, chemistry is an ancient science and activity-oriented course. And its modern foundation was believed to had been laid in the 19th century when intellectual and technological advances enabled the scientists to breakdown substances into ever smaller components and consequently to explain many of their physical and chemical characteristics, and its applications relatively to human demands. Perhaps, it is based on the above that National Policy on Education (NPE, 2004) suggested that the mastery of chemistry concepts cannot be achieved without the effective use of instructional materials. Hence, the inadequacy of these learning materials will certainly result to the poor academic achievement of the students in the particular subject concerned. However Adeyegbe (1998) suggested that the students' achievement in chemistry up to date was nothing to write home about. And he also pointed out that most students find science especially chemistry difficult to understand owning to its abstract nature.

Evidently, many of the senior secondary school students usually drop chemistry-science at the end of SS I class, as being considered the most difficult concept in the school

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curriculum (NERDC, 2005). Therefore, based on this development and for proper academic achievement of the students, many more research works have been carried out to determine the causes of under academic achievement of students in chemistry and other related subjects. And among such findings are as a result of poor laboratory facilities, lack of instructional materials and inability of most science teachers to put across the concepts of chemistry vividly to the students (Jegede, Otuka and Eniayeju, 1999).

Thus, Maduabum (1998) stressed that:

> *A professionally qualified science teacher no matter how well trained, would be unable to put his ideas into practice if the school setting lacks the equipment and materials necessary for him/her to translate his competence into reality.*

Meanwhile, to improve students understanding and their academic achievement, they have to be taught chemistry with hands-on and different teaching-learning materials, so as to enable them acquire both the cognitive and manipulative skills needed for appreciated academic achievement in chemistry. However, in this study, the learning materials used were of improvised and standard models. Though, experience over the years has shown that teachers have been depending on excessive use of words to express process. This practice is termed the "chalk-talk" method. Today, advances in technology have made it possible to produce materials and devices that could be used to minimize the teachers' talking and chalk method of teaching and at the same time make the message clearer, more interesting and easier for the learners to assimilate (Onasanya, 2008).

A model is a copy of real object Kieffer (2000). It is a representation of a system that allows for investigation of the properties of the system and in some cases prediction of future outcomes. Models, aimed at facilitating understanding by eliminating unnecessary components and as well to explain, control and predict concept or event on the basis of past observation: Onasanya (2008), gave various kinds of models used in educational activities as instructional materials, namely; atomic models, molecular models, theoretical models, diagrams, and concrete models etc. These types of models are of special pedagogic significance in science and technology instruction due to the nature of knowledge. These are mostly material objects which are likeness of natural or man-mode structures or systems and which are intended to highlight and explain or describe structure, functional processes and relationship in the original. Onasanya (2008) also summarized the role of concrete models as

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follows; simplification of complex phenomena, bridging of gaps in distance and time between phenomena and classroom events, enhancing the student's academic achievement and ability to communicate in science. However, he also stressed the values of models for instructional design as follows; this requires no special machine for projection, the teacher usually confident in manipulating the material, their improvisation encourages more creativity and diversification of teaching methods, they are very easy to preserve and they could be produced within, minimum cost and maximum efficiency. Therefore, it is based on the above mentioned factors that the researcher decided to investigate into "a comparative analysis of the effect of improvised and standard models on student's achievement in chemistry."

Statement of the Problem

As a result of students' poor performance in chemistry examination, Ogunleye (2000) carried out a survey study on the effective learning and teaching problems of science subjects in secondary schools in Ondo State. And he found out that most of the contributing factors to the poor academic achievement of students in science subjects, especially chemistry in senior secondary schools is as a result of lack of qualified teachers to teach the subject.

Momo (2000) also carried out a research on the effect of instructional materials on students' academic performance in science subjects in Kwara State. He correlates materials resources with academic achievement of students in various science subjects. And from the results obtained, he concluded that material resources have significant effects on students' academic achievement in science subjects. Therefore, inadequate or under utilization of resources materials either improvised or standard ones for the teaching-learning of science subjects in secondary schools in Nigeria would definitely hamper students' academic achievement in such science subjects as; physics, biology and chemistry. Therefore the problem of this study is to investigate the effect of improvised and standard materials in students' achievement in chemistry.

Purpose of the Study

The main purpose of the study was to investigate the effects of improvised and standard models in students' academic achievement in chemistry in senior secondary schools. Specifically, the researcher hopes to;

i.   Determine the effects of improvised and standard materials on students' academic achievement in chemistry.

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ii.   Determine the effect of the use of improvised and standard materials on male and female students' academic achievement in chemistry.

iii.   Determine the effect of interaction between materials and gender on students' academic achievement in chemistry.

Significance of the Study

The use of instructional materials gives the learner the opportunity to touch, smell or taste objects in the teaching and learning process. Consequently, knowledge passed unto the students at different levels of educational instructions should be well planned and properly allied with relevant instructional materials for clarity and comprehensibility. Hence the significance of this study to the students, teachers, curriculum planners, educational system and society at large. Thus, to the students, the effective use of instructional materials either improvised or standardized would enable the students to effectively learn and retain what they have learnt and thereby advancing their academic performance in the subject in question. This is because according to Nwadinigwe (2000), learning is a process through which knowledge, skills, habits, facts, ideas and principles are acquired, retained and utilized; and the only means of achieving this is through the effective use of instructional materials. However, the study would also help to enhance teachers' teaching effectiveness and productivity. This is in line with assertion of Igwe (2003) who noted that it is only the teachers who will guarantee effective and adequate usage of instructional materials and thereby facilitate success. Consequently, a teacher who makes use of appropriate instructional materials to supplement his teaching will enhance students' innovative and creative thinking as well as help them become plausibly spontaneous and enthusiastic.

Scope of the Study

This research work sets out to investigate the effects of improvised and standard materials on students' academic achievement in chemistry. Besides, the study is delimited only to SS 2 science students of the senior secondary schools in Abakaliki metropolis.

Research Question

The following research questions guided the study.

1.   What effect will improvised and standard materials have on the students' mean scores in senior secondary school chemistry achievement?

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2.   What effects have improvised and standard materials on the academic achievement of students in chemistry?

3.   What is the interaction effect of improvised and standard materials and gender on the mean scores of chemistry students in senior secondary school chemistry achievement?

Hypotheses

The following hypotheses were formulated to guide the investigation:

HO_1:   There is no statistically significant difference in academic achievement between students taught chemistry with improvised material and those taught with standard material as measured by their achievement scores.

HO_2:   There is no statistically significant difference in the mean responses of male and female students taught with improvised and standard materials as measured in their achievement scores.

HO_3:   There is no significant interaction effect between materials and gender on students' achievement test in chemistry.

Design of the Study

This study is an experimental design type of research, which involved a pre-test post-test control group experiment. The pre-test post-test is a type of research design applied to determining the stability of an instrument. And an instrument is said to be stable when repeated results obtained from the instrument for a given sample do not fluctuate. In this method, the same test is given to the same group of testees on more than one occasion. Then, the scores obtained by the group on the first administration are correlated with the scores obtained for the same group of testees on the second administration of the same test (Abonyi, Okereke, Omebe, Anugwo, 2006)

Area of the Study

The study was carried out in Abakaliki urban area of Ebonyi State, which consists of twelve (12) secondary schools according to the information gathered from the Secondary Education Board (SEB), 2009 in Ebonyi State.

Population of the Study

The population of this study was all the science students in the six (6) secondary schools selected out of the twelve (12) secondary schools situated within the Abakaliki Urban Area of Ebonyi State.

Sample and Sampling Techniques

The sample size for this study consisted of one hundred and twenty (120) SS II chemistry students which formed intact class from the six (6) secondary schools which was randomly selected out of the twelve (12) secondary schools located within the Abakaliki Urban Area of Ebonyi State.

Research Instrument

The instrument used for the study was chemistry achievement test (CAT). The chemistry achievement test was divided into two main sections; section A and B. section A sought information on the personal data of the respondents. While section B contains twenty (20) items with four (4) options multiple choice objective test which was developed by the researcher based on the topics taught using the standard and improvised materials. Hence, the responses to the questions were to ascertaining the effects of either standard or improvised materials in teaching some chemistry concepts. The questionnaire were administered, collected and collated by the researcher.

Validation of the Instrument

The draft instrument was given to the supervisor and three other experts, one in chemistry education and the other two in measurement and evaluation who critically structured the questions before its administration on the target respondents. This was to ensure the face and construct validity of the instrument.

Reliability of the Instrument

The reliability of the instrument was tested for internal consistency using sixty (60) SS II students from another two secondary schools within Abakaliki Urban Area of Ebonyi State, using Pearson Product Moment formular and reliability co-efficient of 0.85 was obtained. This showed high reliability value.

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Experimental Procedure/Data Collection

The research topic taught and the lesson note on the topics were made and used in teaching both the experimental and control groups for a period of four (4) weeks for two periods per week. The experimental group was taught with improvised materials, while the control group was taught with standard materials.

Therefore, the researcher in collaboration with the chemistry teachers in each school administered the achievement test on the targeted chemistry students. The respondents were left to work independently, the researcher collated respondents' responses on the spot from each school.

Method of Data Collection

The chemistry achievement test (CAT) developed by the researcher was used for data collection. One hundred and twenty (120) students of SS II were used to form intact classes which the chemistry achievement test were administered at. And the respondents' responses were collated from each schools by the researcher with the help of the chemistry teacher of each school.

Method of Data Analysis

The chemistry achievement test (CAT) developed by the researcher was used for data collection. And the data collected were analyzed using mean and standard deviation of covariance (ANCOVA) at an alpha level of 0.05 significance.

Results

The results of this study are presented in tables. The analysis of the data collected from the study was presented in tables according to the research questions and the hypotheses.

Research Question 1

What effect will improvised and standard materials have on the student's mean scores in senior secondary school chemistry achievement?

Table 1: Mean Results of Achievement Based on Materials

Methods	N	$\bar{x}$	SD
Experiment group	4	16.47	1.88
Control group	3	15.68	2.46

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From the above table 1, the result shows that the students taught using an improvised material had mean score of 16.47 and standard deviation of 1.88, while those taught with standard materials had mean score of 15.68 and standard deviation of 2.46. Therefore, based on the findings, it implies that those taught with improvised materials performed better than those taught with standard materials. Notably, experimental group was used for improvised materials, while the control group was used for standard materials.

Research Question 2

What effects have improvised and standard materials on the academic achievement of male and female students in chemistry?

Experimental Group				Control Group			
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	Number
Male	31	16.7188	2.2610	29	16.2414	1.8833	60
Female	28	14.5000	2.1517	32	16.6774	1.8866	60
Total	60	15.6833	2.4598	60	16.4667	1.8818	120

From the above table 2, the result show that the students taught with improvised materials had mean score of 16.7188 for male and 14.500 for female with the relative standard deviation of 2.2610 and 2.1517. While those taught with standard materials had mean score of 16.2414 for male and 16.6774 for female students with their respective standard deviation of 1.8833 and 1.8866. Therefore, this suggested that there is no significant effects of improvised and standard materials on the academic achievement of male and female students in chemistry, inspite of the slight difference in their mean scores.

Research Question 3

What is the interaction effect of improvised and standard materials and gender on the mean score of chemistry students in senior secondary school chemistry achievement?

Experimental Group				Control Group			
	N	$\bar{X}$	SD	N	$\bar{X}$	SD	Number
Male	32	16.72	2.2610	29	16.24	1.8833	60
Female	28	14.50	2.1517	31	16.68	1.8866	60
Total	60	31.22	4.4127	60	32.92	3.7699	120

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From the above table 3, the result shows that male and female students taught with improvised materials had mean score of 16.72 and 14.50 for with standard deviation of 2.2610 and 2.1517. While those taught with standard materials had mean score of 16.24 and 16.68 with standard materials had mean score of 16.24 and 16.68 with standard deviation of 1.8833 and 1.8866 respectively.

Hypothesis 1

There is no statistically significant difference in academic achievement between students taught with improvised materials and those taught with standard materials as measured by their achievement scores.

Table 4: ANCOVA Results Based on Materials

Source of variation	Sum of squares	DF	Mean square	Cal f	Sign of F	f-critic
Covariates	99.747	1	99.747	28.455	.000	
Pre-test	99.747	1	99.747	28.455	.000	
Main effects	74.438	1	74.438	21.235	.000	
Material	74.438	1	74.438	21.235	.000	3.92
Explained	174.186	2	87.093	24.845	.000	
Residual	410.139	117	3.505			
Total	584.325	119	4.910			

Significant at P<0.05

The data were analyzed using ANCOVA with pretest value as covariates. Thus, result according to table 4 is significant. However, this implies that the null hypothesis H_{O1} of no significant difference is rejected. Therefore, multiple classification analysis (MCA) was carried out to determine the degree of contribution of each material.

Table 5: Multiple Classification Analysis Result of Significance

Variable + category	N	Unadjusted deviation	Eta	Adjusted for independents + covariates deviation	Beta
Improvised materials	60	-39		-85	
Standard materials	60	.39		.85	
			.18		.38
Multiple R Squared					.298
Multiple R					.546

Grand mean = 16.08

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From the table 5 above, the grand mean score for students under the experimental group is 15.83 and those under the control group had an adjusted mean score of 16.93. However, this implies that there is a significant difference in the grand mean score of students exposed to such materials.

Hypothesis 2

There is no statistically significant difference in the mean responses of male and female students taught with improvised and standard materials as measured in their chemistry achievement scores.

Table 6: ANCOVA Result Based on Gender

Source of variation	Sum of squares	DF	Mean square	Cal f	Sign of F	f-critic
Covariates	99.747	1	99.747	24.449	.000	
Pre-test	99.747	1	99.747	24.449	.000	
Main effects	7.239	1	7.239	1.774	.185	
Gender	7.239	1	7.239	1.774	.185	3.92
Explained	106.986	2	53.493	13.112	.000	
Residual	477.339	117	4.080			
Total	584.325	119	4.910			

Not significant P<0.05

Thus, the data were analyzed using ANCOVA with pretest value as covariates. The result obtained was not significant, so the null hypothesis, H_{O2} of no significant difference is accepted. Therefore, multiple classification analysis (MCA) was not carried out anyway.

Hypothesis 3

There is not significant interaction effect between materials and gender on students' achievement test in chemistry.

Table 7: ANCOVA Results Based on Interaction between Materials and Gender

Source of variation	Sum of squares	DF	Mean square	Cal f	Sign of F	f-critic
Covariates	99.747	1	99.747	29.363	.000	
Pre-test	99.747	1	99.747	29.363	.000	
Main effects	80.472	2	40.236	11.844	.000	
Gender	7.239	1	7.239	2.131	.147	3.92

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Material	73.232	1	73.232	21.557	.000
2-way interactions	13.442	1	13.442	3.957	.049
Gender x materials	13.442	1	13.442	3.957	.049
Explained	193.661	4			
Residual	390.664	115	3.397		
Total	584.325	119	4.910		

Significant at < 0.05

The data were analyzed using ANCOVA with pretest values as covariates. Thus, the result according to table 7; is significant, since the exact probability P (0.049) is less than 0.05, indicating that the null hypothesis H_{o3} of no significant is rejected. Therefore, the multiple classification analysis (MCA) was carried out to check-mate the extent of the effect.

Table 8: Multiple Classification Analysis of Significance

Variable + category	N	Unadjusted deviation	Eta	Adjusted for independents + covariates deviation	Beta
Gender (1) male	61	-42		.23	
(2) female	59	-39		-23	
			.19		.10
Material (3) improvised material	60	-39			.298
(4) standard materials	60	.39			.546
			.18		.38
Multiple R squared					.308
Multiple R					.555

Grand mean = 16.08

From the table 8, above the grand mean score of the students under the experimental group is 15.24, and those under the controlled group is 16.92. Thus, this also confirms that there were interaction effects between materials and gender on students academic achievement test in chemistry. Hence the difference is their respective grand mean scores.

Summary of Findings

1. The result obtained in table 1 showed that the students taught using an improvised material had a mean score of 16.47 as against the mean score of 15.68 of those taught with standard materials. However, this implies that those taught with improvised materials performed better than those taught with standard materials.

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2. From the findings, the mean score of male and female students differ based on treatment level as shown in table 2 of research question 2. It revealed that the mean score of male students taught with both an improvised and standard materials was slightly high as against the mean score of the female students taught with the same materials. Hence, there is a significant effect of materials on the academic achievement of male and female students in chemistry.

3. From the findings, there is no statistically significant difference in the mean responses of male and female students taught with improvised and standard materials as measured in their chemistry achievement scores.

4. There is significant interaction effect between materials and gender on students' achievement test in chemistry, as showed in table 7 which is significant at <0.05.

Discussion

This chapter presents the discussion of result presented in chapter four. However, the result from table 1: show that the mean achievement scores of student in the experimental group were slightly higher than that of student in the control group. Thus, from the table, the results shows that the students taught with improvised materials had mean score of 16.47 and standard deviation of 1.88, those taught with standard materials had mean score of 15.68 and standard deviation of 2.46. So, this is an indication that the students taught using improvised materials perform better than those taught with standard materials. Therefore, using an improvised instructional material to involve the students in teaching-learning process goes along way in enhancing their achievement in the designed lesson. Because according to Ibe and Nwosu (2003) an improvised instructional materials do not only improve the student's performance in the classroom activities but it also helps them to internalize learning and to acquire the science process skills for depth understanding of science concepts. Obviously, improvised instructional materials are necessary as Okebukola (1998) holds that to teach is to improvise.

Furthermore, the result in table 2 revealed that both the male and female students in an experimental and controlled group have slightly similar mean scores, meaning that there is no significant difference in the response of male and female students taught with improvised and standard materials. Thus, this is further confirmed by the ANCOVA result in table 6: which revealed that gender response was not significant factor on student's achievement in chemistry.

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Finally, ANCOVA result in table 7: also revealed that the interaction between the materials and the gender has a significant effect on the students' achievement in chemistry. Thus, this was substantiated by multiple classification analysis (MCA) of significance in table 8

Recommendations

From the results obtained from the data collected in this work, I recommend that:

1. The adequate orientation should be given to teachers on how to improvise alternatives to real objects in order to improve the quality of teaching.

2. The need to update teacher's knowledge on materials for teaching of chemistry and acquaint them with other new innovations is also to be enhanced. This could be made possible by frequently organizing seminars, workshops and in-service training for chemistry teachers.

3. The teacher should make use of different instructional materials as long as they are relevant to their lesson content.

4. There is also the need for the teachers to be resourceful in materials selection and planning. This is to reduce the cost of production and maintenance of instructional materials; local production and improvisation have always been a positive step towards the realization of this suggestion.

5. Improvisation should be encouraged and the learners should be actively involved since the rule of retention states that people retain more of what they hear, see and do or touch.

6. The government, non-governmental organizations (NGOs) and the PTA should contribute financially to the promotion of improvisation of instructional materials in secondary schools; colleges of Education and Universities.

Conclusion

Improvised materials should not only be used or encouraged as useful models where application depends on change and circumstances but should be justified as strategy in such difficult times. But it should be seen as available integral part of teaching even when the school budget is sufficient to cater for standardized materials. However, it was gathered from the findings that there was an evidence of improvement in students' academic achievement in chemistry through the use of improvised materials. And this was also substantiated from the result obtained from table 1 and table 4 of ANCOVA results based on materials in chapter four (4).

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