

COMPARATIVE EFFECTS OF TEACHING WITH IMPROVISED INSTRUCTIONAL MATERIALS
AND STANDARD INSTRUCTIONAL MATERIALS ON SECONDARY SCHOOL STUDENTS'
ACADEMIC RETENTION IN CHEMISTRY

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Abstract

This study investigated the comparative effect of teaching with improvised instructional materials and standard instructional materials on secondary school students' academic retention in Chemistry. It covered the topics; acids, bases and acid- base reactions. Two research questions and two hypotheses were used to guide the study, relevant literatures were also reviewed. The study was carried out in Awka education zone in Anambra State. The population of the study consists of 8,583 SS1 Chemistry students in the zone. The sample size for the study comprised of 192 SS1 Chemistry students. The study adopted quasi-experimental design. Four purposively selected co-educational schools were used for the study of which students of chemistry in two schools were assigned to experimental group which received treatment of involvement in teaching Chemistry using improvised instructional materials and the other two schools were assigned to control group which were taught using standard instructional materials. Twenty-five (25) Chemistry Retention Test (CRT) was used as the instrument. The instrument was validated by experts in science education department and education foundation (measurement and evaluation) CRT reliability was established using Kuder Richardson 20 (KR-20) which yielded reliability coefficient of 0.81. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at .05 level of significance. The findings of the study revealed that, there was high knowledge retention when Chemistry students were taught using improvisation instructional material than those taught with standard instructional material and gender has no influence on use of improvised 2instructional material and standard instructional material. Based on the findings of the study, recommendations were made.

Keywords; Science, Chemistry, Retention, Standard Instructional Material (SIM) and Improved Instructional Material (IIM)

Introduction

Science is important in the development of any nation. This is because science is directly linked to the tackling of the problems of humanity. The contributions of science and technology to the overall development of nations cannot be overemphasized. This is the reason science holds an important position in the curriculum of the nation's educational system. It was in the bid to further underline the importance of science and technology to modern development that Science, Technology, Engineering and Mathematics (STEM) education was introduced in 2001 by the Scientific Administrators at the US National Science Foundation (NSF) with three major goals; to expand the number of students who ultimately pursue advanced degrees/careers in STEM fields and broaden participation of woman and minorities in those fields, expand STEM- capable workforce and increase STEM literacy for all students including those who do not pursue STEM related careers or additional studies in STEM disciplines (Hallinen, 2011).

STEM education is an integration of interrelated discipline into a new whole, which gives students the opportunity to understand their environment and exploit it for self and national development (Hallinen,2011). The interdisciplinary nature of STEM makes it unique as it has elements of creativity and objectivity. Strong STEM education is culturally responsive, employs problem-solving and inquiry-based approaches and engages students in hand-on activities that offer opportunities to interact with science professionals (Tera, 2018). However, Samuel and Obikezie (2020) define science as the rational and systematic study of the environment through observation and experimentation with a view to understanding the environment and manipulating the resources of nature for human development. This implies that teaching must be proactive, creative and student centered to achieve the objectives of STEM at secondary school level. The authors also asserted that one of the activities of science is experimenting, it provides a forum for putting the theoretical knowledge acquired in the classroom into practice and also, to demonstrate the psychomotor skills of the teacher and students in teaching and learning subject like Chemistry through experimentation. Experimenting in science is however dependent on the availability of instructional materials (Ogwo, 2014).

Lack of instructional materials, non-availability of equipped laboratories among others in the teaching of science in schools is an established issue (Ezeliora, Ibe & Obikezie, 2021). This is in line with Odigie (2011) and Dike (2013) who agreed that educational instructional materials and equipped laboratories are lacking in schools. Ezeliora, Ibe and Obikezie (2021) are of the opinion that the use of instructional materials to facilitate teaching and learning should be a welcome development because it help in enhancing students academic performance and retention. This is in conformity with Dike (2013) who asserts that science teachers should work beyond stereotyped science teaching-learning process and utilize the available materials in the environment to facilitate effective science teaching-learning process. Therefore for effective teaching of science subjects like Chemistry, the use of instructional materials to enrich instruction is very vital (Dike, 2013).

Chemistry is one of the core subjects of science. As a building block for a range of science disciplines, Chemistry has the potential to link other sciences together and to foster greater scientific literacy (Tera,2018). Chemistry is the basic gateway and the key to modern technology, medicine, engineering and other sciences (Chikendu, Obikezie & Eke, 2021). The study of Chemistry is needed to develop the necessary skills, intellectual and mental training needed to observe measure and apply scientific attitude and skill towards natural phenomena that include the eagerness to learn and the ability to think critically. In contemporary Nigeria, great emphasis is placed on science for technological development and Chemistry is an important raw material for science. In spite of the relevance of Chemistry in the life of the society, the study of Chemistry in our secondary schools is challenged with poor performance and lack of interest on the part of students (Obikezie & Abumchukwu 2021).

According to Obikezie, Abumchukw and Chikendu (2021) factors responsible for students' poor performance in Chemistry include – ineffectiveness in teaching process, poor laboratory facilities and inadequate number of learning facilities in schools as against the consistent increase in the number of students. Other reasons adduced for poor performance in Chemistry include abstract nature of Chemistry, student and teacher factors, concept difficulty and teaching of Chemistry without instructional materials (Nnoli, 2014).

WAEC Chief Examiners' report (2018) pointed out that Chemistry students' have poor knowledge of acids, bases and acid-base reactions and are unable to report results of acid-base titration experiments, unable to make calculations on molar and mass concentration. These topics are fundamental and basic concepts in Chemistry. Judging from the percentage analysis of those who passed Chemistry at credit level in WAEC over the years, there has not been consistent increase in the percentage of students who enrolled and passed at credit level. From 2007-2012, the percentage of those who passed at credit level was below 50% except in 2011. From 2013 to 2018, although, the percentage of those who passed at credit level was above 50%, still a good number of the registered students failed it resulting to dropout in science careers in higher institutions of learning (Samuel & Obikezie 2020). Could it be that the dropout in science careers is as a result of non availability of instructional materials?

Ogwo (2014) stated that the basic tools that science uses in the learning of science processes are instructional materials. Instructional materials are wide varieties of equipment and materials used for teaching and learning processes to stimulate self-activity on the part of the students. According to Engida (2012) instructional materials increase the rate and quantity of learning by students and at the same time allow the teacher to use more time on other gainful activities. They make abstract terms, concepts and generalizations more practical and realistic. Instructional materials create in the learners' awareness of problem, open up possibilities for exploration, present meaningful interactions which naturally lead to provision of solutions. Chemistry as a science subject is hands on activity based and must be taught with instructional materials (Ezeliorah, Ibe & Obikezie 2021). Teaching of Chemistry without instructional materials may result to rote learning.

Due to the galloping inflation in the country, foreign exchange rate is high and makes it impossible for schools to purchase already made instructional materials which are often imported into the country. For these reasons and even more, Chemistry teachers have been called upon to be creative in improvising these instructional materials so that in the absence of standard ones or when the number is not adequate, the teacher can locally make use of resources from the environment as an alternative (Ezeliora, Ibe & Obikezie 2021). The importance of using instructional materials whether standard or improvised according to Oriade (2008) is that no matter how good a curriculum may be, the absence of the use of instructional materials can jeopardize its effective implementation. Instructional resources help the teachers to improve their instruction. They make the message clearer, more interesting, standard and easier for the learners to assimilate (Onasanya & Adegbija, 2012).

There are two major types of instructional materials: standard instructional material used as conventional in this study and improvised instructional material used as experimental parameter in this study. The standard materials are conventional instructional materials that are imported or factory made laboratory equipment for teaching science. They are standardized because they adapt to all conditions and serve the same purpose wherever they are used. Examples are laboratory chemicals, laboratory glassware, bunsen burners, tripod stand etc, while improvised materials refer to a diversity of educational resources that can easily be obtained from the environment, with high local content and relevance to the curriculum (Engida, 2012). They are used as instructional materials for teaching and learning purposes. They are made by the teacher or students. Improvised materials include; sodium rich materials as base, such as akanwu, ugwu dyes of plants and flowers (zobo) as acid base indicators. Standard Instructional Material (SIM) and Improvised Instructional Material (IIM) may have effect on students' academic performance and retention in learning science (Ez2eliora, Ibe & Obikezie, 2021).

Retention is the ability to store what has been learnt and recall what has been stored in the memory. According to Obikezie, Abumchukwu and Chikendu (2021) retention is the ability to retain and later remember information or knowledge gained after learning into memory. The authors further added that the nature of the resources to be coded contributes to the level of retention. Retention is, therefore, the ability to recall learning experiences after about three weeks of learning and beyond. Conditions that relate to poor retention include such factors like lack or inadequate use of instructional materials. Insufficient use of instructional materials in the process of teaching and learning Chemistry can lead to poor retention of knowledge among genders in classroom (Ikwuanusi, 2011).

Genders as an important determinant factor in an educational setting constitute a hindrance to students' retention in Chemistry and have received research attention for some years Attah (2014). According to Attah (2014) gender is not a significant factor in students' retention in science. In the other hand, Okwuduba and Okigbo (2018) identified sex-role stereotyping and masculine image of science as the origin of the differences between male and female retention in sciences. In relation to the present study, since gender has proved a significant

determinant of academic retention in Chemistry and in other science subjects in some comparative studies.

Engida (2012) reported that Chemistry students taught using improvised instructional materials performed excellently well and retained what they had been taught more students taught using standard instructional material in Kogi state. Similarly, Attah (2014) revealed that there was a significant difference between retention scores of students taught science subjects with improvised instructional materials when compared with those taught with standard instructional materials in Nsukka in favour of students taught with improvised instructional material. The author further stressed that female students proved superior to male students in retention in using both improvised and standard instructional materials, that is to say that a significant differences exist male and female students taught science with improvised and standard instructional material in favour of female students. In contrary view, Ibrahim (2012) observed that there was no significant difference in the mean retention between male and female students taught Biology using improvised instructional material and those taught with standard instructional materials in northern Kaduna. Ibe (2021) maintained that there was a significant difference in mean scores in a comparative study of secondary school Chemistry students taught with improvised instructional material and those taught with standard improvised instructional material in favour of those taught with improvised instructional material. Ibe further opined that in as much that improvised instructional material improves academic retention of secondary school Chemistry students when compared with standard instructional material, that there is a significant different in academic retention of male and female Chemistry students who were taught with improvised instr2uctional material and standard instructional material in favour of male students . In a comparative study carried out by Okwuduba and Okigbo (2018), the researchers observed that there was a significant difference when students were taught with cooperative learning strategy and think pair learning strategy in favour of those taught with think pair share learning strategy. The authors maintained that think pair share learning strategy enhances students' academic retention in Chemistry than cooperative learning strategy in Ogidi education zone. The above comparative studies reviewed were done outside the present scope of study. However the researchers wish to investigate the comparative effect of teaching with improvised instructional materials and standard instructional materials on secondary school students' academic retention in Chemistry.

Realizing the importance of Chemistry for national development, a lot of students tend to register Chemistry in secondary school. This has resulted to large surge of students in Chemistry giving rise to large number of students in one class. Unfortunately the increase in number of students has not been matched with the supply of instructional materials in the laboratories. This has made Chemistry teachers to teach Chemistry with little or no instructional materials. This has constituted difficulties in the teaching and learning of practical Chemistry. Without the use of instructional materials in teaching and learning of Chemistry which supposed to be activity based, do not help the students to understand Chemistry concepts. The consequences are rote learning, lack of retention.

Secondly, students have not been performing well in the following Chemistry topics acids, base, acid-base reaction, calculations of molar and mass concentration. However, most Chemistry laboratories are equipped with standard instructional materials which are at times not enough or even not available. This has made it inevitable for Chemistry teachers to improvise teaching resources.

Teachers are encouraged to engage in improvisation of instructional materials to avoid teaching Chemistry without instructional materials. Thus, the crux of this study if put into question is: what is the comparative effect of teaching with improvised instructional materials and standard instructional materials on secondary school students' academic retention in Chemistry in Awka education zone of Anambra state Nigeria?

Purpose of the Study

The purpose of the study is to investigate the comparative effect of teaching with improvised instructional materials and standard instructional materials on secondary school students' academic retention in Chemistry. Specifically, the study sought to achieve the following:

1. Mean retention scores of students taught Chemistry using improvised instructional materials (IIM) and those taught using standard instructional materials (SIM)
2. Mean retention scores of male and female students taught Chemistry using improvised instructional materials (IIM)

Research Questions

The following research questions guided the study;

1. What is the difference in the mean retention scores of students taught Chemistry using improvised instructional materials and those taught using standard instructional materials?
2. What is the difference in the mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught using standard instructional materials?

Hypotheses

The study tested the following null hypothesis at 0.05 level of significance.

1. There is no significant difference in the mean retention scores of students taught Chemistry using improvised instructional material and those taught using standard instructional material.
2. There is no significant difference in the mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught using standard instructional material.

Methods

The design of the study was quasi-experimental design of pretest-posttest non-equivalent control group design. Quasi-experimental design is where random assignment of subjects to experimental or control groups is not possible (Nworgu, 2015). In such research, intact classes were used. The design is considered appropriate for the study because treatment and control groups are used. The study was carried out in Awka Education Zone of Anambra state, Nigeria. Awka Education Zone comprises of five Local Government Areas namely; Awka North, Awka South, Anaocha, Dunukofia and Njikoka local government area respectively. To obtain this study, four co-educational government owned secondary schools were chosen out of forty nine (49) co-educational government schools in the area. Two schools were assigned to control group, the other two were also assigned to experimental group. Out of 8583 SS1 students in Awka education zone 192 SS1 students were selected using purposive sampling technique. One hundred and four students (104) expunge and comprising fifty four (54) male students and fifty (50) were assigned to experimental group who were taught with improvised instructional materials. In like manner, eighty eight students (88) were assigned to control group forty eight (48) male students and forty (40) female were assigned to control group who were taught Chemistry concept using standard instructional material. The instrument for data collection was Chemistry Retention Test (CRT). CRT was developed by the researchers from the West Africa Examination Council (WAEC) past questions. The instrument was validated by two experts one from department of Chemistry Nwafor Orizu Collage of education Nsugbe and one from department of education foundation Chukwuemeka Odumegwu Ojukwu University Igbariam Campus. The reliability co-efficient of CRT was established by administering the instrument to 25 Chemistry students in Enugu state which is outside the place of study using Kuder Richason formula and score obtained was 0.81. Mean and standard deviation were used to answer research questions while analysis of covariance (ANCOVA) was used to test the hypothesis at .05 level of significance

Research Question one: What is the difference in the mean retention scores of students taught Chemistry using improvised instructional materials and those taught using standard instructional materials?

Table 1: Mean and Standard Deviation Scores of the Retention Score for Students Taught

Chemistry with Improvised Instructional Materials and those Taught with Standard Instructional Materials.

Instructional Material	N	$\frac{\text{Mean}}{X}$	SD	$\frac{\text{Mean Difference}}{X}$
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Improvised Instructional Material Group (IIM)	104	59.08	7.50	6.51
Standard Instructional Material Group (SIM)	88	52.64	8.16	

Table 1 shows that the mean retention scores of students taught with improvised instructional materials and standard instructional materials were 59.08 and 52.6 respectively. The difference in mean retention score of 6.5 implies that students taught Chemistry with improvised instructional materials had better retention in Chemistry than their counterparts taught with standard instruction materials. The standard deviation scores for the two groups were 7.50 and 8.16, indicating that students taught with the improvised instructional materials had slightly more variability in their retention scores.

Research Question Two: What is the difference in the mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught using standard instructional materials?

Table 2: Mean and Standard Deviation Retention score for Male and Female Students Taught Chemistry with Improvised Instructional Materials and those Taught with Standard Instructional Material

Instructional Material	Gender	N	Mean \bar{X}	SD	Mean Difference \bar{X}
Improvised Instructional Materials (IIM)	Male	54	60.15	7.69	2.23
	Female	50	57.92	7.19	
Standard Instructional Material (SIM)	Male	48	51.01	6.10	4.09
	Female	40	46.92	5.90	

Table 2 presents the Chemistry mean and standard deviation Chemistry retention scores of male and female students taught with improvised instructional materials and those taught with standard instructional material. The mean and standard deviation retention scores of male students taught with improvised instructional material were 60.15 and 7.69 whereas those of female students in the same group were 57.92 and 7.19. However, the mean gain difference between male and female students taught Chemistry concepts using IIM was 2.23 in favour of male students. This implies that in use of improvised instructional materials, male students had better retention in Chemistry than their female counterpart. More so, the mean and standard deviation retention scores of male students taught with standard instructional material were 51.01 and 6.10 whereas those of female students in the same group were 46.92 and 5.90. However, the mean gain difference between male and female students taught Chemistry concept using SIM was 4.09 in favour of male students as well.

This implies that in use standard instructional material, male students had better retention in Chemistry than their female counterpart.

Hypothesis 1

There is no significant difference in the mean retention scores of students taught Chemistry using improvised instructional material and those taught using standard instructional material.

Table 3. Summary of Analysis of Covariance of Main Effect of Mean Retention Scores of Students Taught Chemistry using Improvised Instructional Materials and those Taught with Standard Instructional Materials.

Source of Variation	Sum of Squares	Df	Mean Square	F	p-value
Pretest	1678.11	1	1678.11	32.01	.000
Instructional Materials	2103.19	1	2103.19	40.11	.000*
Error	9909.64	189	52.43		
Total	13565.00	191			

*Significant

Table 3 shows there was a significant of mean retention scores of students taught Chemistry with improvised instructional materials and those taught with standard instructional materials $F(1, 187) = 40.11, P = .000$. Since the obtained p-value of .000 was less than the 0.05 level of significance, the null hypothesis which stated that the two groups will not differ significantly was rejected. This implies that students taught Chemistry using improvised instructional materials had greater mean retention score than those taught with standard instructional materials. This implies that the significant difference was in favour of those taught chemistry using improvised instructional materials.

Hypothesis 2

There is no significant difference in the mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught using standard instructional material.

Table 4. Summary of Analysis of Covariance of Mean Retention Scores of Male and Female Students Taught Chemistry with Improvised Instructional Materials and Those with Standard Instructional Material.

Source of Variation	Sum of Squares	Df	Mean Square	F	p-value
Posttest in	1408.38	1	1408.38	33.37	.000

IIM					
Gender in	58.42	1	58.42	1.38	.242*
IIM					
Error	4262.11	101	42.20		
8					
Posttest in	1514.00	1	1408.38	23.17	.000
SIM					
Gender in	62.42	1	58.42	1.00	.151*
SIM					
Error	488.11	87	42.20		
Total	3215.38	88			

*Not Significant

As shown in table 4, there was no significant difference in mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught with standard instructional material, $F(1,101) = 1.38$, $P = .242$ and $F(1,87)=1.00$, $P=.151$, since the obtained p -value of .242 was greater than 0.05 level of significance in IIM and p -value of .151 was greater than 0.05 level of significance in SIM; The null hypothesis which indicated that there was no significant difference in the mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught using standard instructional material was not rejected. Though the male students obtained higher mean score than the female students was not high to be significant difference. This implies that both male and female students retained equally when taught with both instructional materials.

Discussion

The findings of the study showed that students taught Chemistry with improvised instructional materials showed higher retention than when compared with those taught with standard instructional materials. The result showed a statistically significant difference in retention between the two groups in favour of improvised instructional material. This result is in conformity with the findings of Engida (2012) reported that Chemistry students taught using improvised instructional materials performed excellently well and retained what they had been taught more students taught using standard instructional material in Kogi state. The result is also in line with Attah (2014) who revealed that there was a significant difference between retention scores of students taught science subjects with improvised instructional materials when compared with those taught with standard instructional materials in Nsukka in favour of students taught with improvised instructional material. The high retention in Chemistry students from improvised instructional material group could be as a result of originality of the materials used in teaching the students. It could also be that the students were able to identify the local materials used in constructing or developing the instructional materials which help the students to assimilate and retained the Chemistry concept easily.

The finding of the study also showed that there was no significant difference in mean retention scores of male and female students taught Chemistry using improvised instructional materials and those taught with standard instructional material. This result is in consonance

with Ibrahim (2012) who observed that there was no significant difference in the mean retention between male and female students taught Biology using improvised instructional material and those taught with standard instructional materials in northern Kaduna. The result of no significant difference in both instructional material groups could be as a result of the ability of male and female Chemistry students to comprehending and making use of instructional material giving to them not minding if it improvised or standard instructional material which lead to high and equal retention not minding the gender.

Based on the findings of this study, the following conclusions were drawn: the use of improvised instructional material enhances students' retention than improvised instructional material. Also gender has no influence in academic retention of students when taught Chemistry with improvised instructional strategy and standard instructional strategy

Recommendations

The following recommendations are made in the light of the findings of the study:

1. School administrators should also provide financial support for the acquisition of the materials from which improvised instructional materials can be made since they are cheap and readily available.
2. Chemistry teachers to be resourceful in materials selection and planning.
3. Chemistry teachers should seek individual knowledge on how they can convert local materials in their immediate environment as alternatives to standard materials needed for Chemistry instructions.

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