EFFECTS OF INSTRUCTIONAL MATERIALS ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN CHEMISTRY IN ENUGU STATE

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ABSTRACT

This study investigated the effects of instructional materials on academic achievement of secondary school students in chemistry in Enugu State. It covered the topic: matter. Two research questions and two null hypotheses formulated guided the study. Quasi-experimental design and purposive sampling technique were used to select 40 schools from about 50 schools in the sampling zone population. A sample of 20 senior secondary class 2B (SS2B) chemistry students of 10 males and 10 females randomly selected were employed for the study. Researchers developed Chemistry Achievement Test (CAT) instrument on the topic to collect data for pretest-posttest approach. The instrument was validated by experts before it was used. The students were taught with and without instructional materials and assessed accordingly. Mean and standard deviation were used to answer the research questions while analysis of variance (ANOVA) was used to test the hypotheses at the level of 0.05. The findings showed that students taught with instructional materials (experimental group) achieved higher than those taught without instructional materials (control group). It was also found that the male students performed better than their female counterparts in both treatments. The findings recommend that teachers in the field should adopt the use of instructional materials in teaching chemistry, and also work more closely with the female gender for the improvement of the students' academic achievement in chemistry. *[African Journal of Chemical Education—AJCE 15(1), January 2025]*

INTRODUCTION

The quality of education is dependent on the availability and use of learning or instructional materials, and also quality of teachers that undertake the task of what to teach (the methodology) and how to teach (materials to use) it to their students and learners [1].

Science is the methodical and logical study of the environment through observation and experimentation with the goal of comprehending the environment and utilizing natural resources for human growth, according to Dike [2]. According to the Ibe et al. [3] and NERC [4], providing and utilizing readily available instructional materials for instruction lays a solid foundation for students' scientific and reflective thinking. Students are able to make connections between abstract concepts they are taught and experiences they have had in real life. Additionally, it supports scientific inquiry, discovery, and investigative approaches while pushing pupils to develop their creative faculties. Moreover, it offers a framework for students to focus on during class activities, helps teachers come up with quicker, cheaper, and better ways to simplify the teaching and learning process for students, and gives students the chance to get acquainted with the tools in their surroundings.

Chemistry is a branch of science which deals with the study of the structure, composition, properties and reactions of matter in different forms. Chemistry is very important in the technological development of the nation. Chemistry has helped in the development of modern technology through the application of its principles in modern invention [5, 6].

The problem of students' persistent underachievement in chemistry at the secondary level of education is undoubtedly unimpressive and worrisome because in Nigeria and most other countries a credit pass in chemistry is a pre-requisite for further studies in fields such as medicine, pharmacy, agriculture, engineering, home economics, biological Science and other science related courses of study [7]. The problem of the students' poor achievement in chemistry may be attributed to the use

of inappropriate and ineffectiveness in the teaching method and nonuse of use of instructional materials by chemistry teachers [3, 8], because the principle function of pedagogy is to ensure that ideas and information are meaningfully presented, clear and retained over a long period of time [9]. Another reasons adduced for poor achievement in chemistry include abstract nature of chemistry, student and teacher factors, concept difficulty and teaching of chemistry without instructional materials [10]. The negligence in the effective use of the instructional facilities and materials in teaching and learning of chemistry is common to both trained and untrained teachers, and this might have effect in successful academic performance of students in chemistry in secondary schools in Enugu State as reported by Department of Statistics, Planning and Research, Ministry of Education, Enugu, 2007. Teaching aid/instructional material is an essential part of teaching methods which helps the teacher to express its subject concept to the learners thus promoting students' academic performance [11, 12, 13]. Its use in promoting teaching at secondary school level in Nigeria is supported by Sections 4-23 of the Nigerian National Policy on Education, NPE [14, 15] and it comprises of all available, suitable and accessible, theoretical and practical skill oriented resources which facilitate the learning, acquisition and evaluation of vocational skills [16], such as charts, maps, diagrams, comics, models, globes, slides, film strips, television, radio cassettes, video, recorders, cinema, public address system, laboratories and museums, flash cards, flannel boards, card boards, calendar, computers, etc. [17]. Improvised instructional materials has been found has been found to improve students retention more than the standard instructional materials. For instance, the students taught chemistry with improvised instructional materials had better retention in chemistry than their counterparts taught with standard instructional materials, with their scores resulting in a standard deviation of 59.08 and 52.6 respectively, and mean retention score of 6.5 [3]. A researcher, Enohuean [18] employed quasi experimental design to administer WAEC biology

questions to students in Delta State Nigeria and stated from his results that there is significant difference in the mean retention scores of students taught biology concepts with the use of instructional materials and their counterparts taught without instructional materials. Instructional materials save the time and energy and promote retention in the course of teaching and learning [3, 6, 18] and achievement in Chemistry which involves a lot of simple tests and activities [19, 20, 21, 22].

Gender as a factor in science achievement has generated a lot of concern for science educators and it has been observed that sex has significant effect in cognitive achievement [23]. Gender has no significant effect on the student retention scores when they are taught without instructional materials [18]. However, male students performed better and are more favoured compared to their famale counterparts [3]. For, there is mean gain difference of 2.23 in chemistry retention test score between male and female students which was in favour of male students, according to Ibe et al. [3].

The major objective of this study is to determine the effects of instructional materials on academic achievement of secondary school students in chemistry in Enugu State, Nigeria.

Purpose of the Study:

The study is intended to:

1. determine the effect of instructional material on the academic achievement of students in chemistry.
2. determine the academic achievement of male and female students taught with instructional materials and their counterparts taught without instructional materials in chemistry.

Research questions:

The following research questions guided the conduct of the study.

1. What are the mean achievement scores of students taught chemistry using instructional material and those taught without instructional material?
2. What are the mean achievement scores of male and female students taught using instructional material and those without the use of instructional materials, as measured by Chemistry Achievement Test (CAT)?

Hypotheses:

The following null hypotheses guided the study were tested at 0.05 level of significance in the course of the research:

$H0_1$. There is no significant difference between the mean achievement scores of students taught chemistry using instructional material (experimental group) and those taught without instructional material (control group).

$H0_2$. There is no significant difference on the mean academic achievement scores on gender amongst students taught chemistry by incorporating instructional materials as measured by Chemistry Achievement Test (CAT) and those taught without instructional materials.

METHODOLOGY

The design is a quasi-experimental which involves selecting groups, upon which a variable is tested without any random pre-selection processes, and the design employed where the treatment and control is evaluated; then after this selection, the experiment is expected to proceed in a very similar way to any other experiment, with a variable being compared between different groups, or

over a period of time [3]. Enugu State, Nigeria, has a total population of 3,257,298 based on population census of 2006, and the population of Enugu metropolis is expected to rise by 3.49% in 2024 (that is about 876,000). Enugu education zone is the center of education zone in Enugu State and it is made of federal, state and private schools. Chemistry as a subject is usually offered in senior secondary classes, and science students are expected to be more conversant with the subject at senior secondary class two (SS2) due to the external examinations such as conducted exams of West African Examination Council (WAEC), National Examination Council (NECO), and others they are expected to write to conclude their secondary education. Enugu State boosts of over 300 public secondary schools, and about 50 secondary schools located in Enugu metropolis, comprised of Enugu North, Enugu East and Enugu West Local government areas, out of the 17 local government areas in the state. The population area of the study focused on Enugu education zone due to its strategic importance. The population for the study consisted of 20 senior secondary class two B (SS2B) chemistry students randomly selected from 40 secondary schools based on purpose from Enugu metropolis in the 2023/2024 session. The students were selected to make up an even number of 10 males and 10 females. Chemistry Achievement Test (CAT) of 20 multiple choice objective questions developed by the researchers were administered to the students for a duration of 20 minutes after teaching with (experimental group) and without (control group) instructional materials. The measuring instrument used was based on chemistry theoretical content of Matter.

Instrument

The instrument for data collection was through a pretest-posttest of the Chemistry Achievement Test (CAT) questions developed by the researchers and administered by the researchers and some regular teachers employed by the researchers. The reliability of the instrument

was certified by the experts in the Department of Vocational Science Education, Godfrey Okoye University, Enugu, before it was used. The researchers' lesson plan and 20 test questions (objective) were used for both the teachings and test administration. After the teaching of the control group (without instructional material), the test (pretest) was administered to them. The same 20 multiple choice objective questions were used to re-test (posttest) the same students in duration of 20 minutes after teaching them with instructional materials, the same condition of the first administration. The data results from the pretest-posttest conditions was collected and used for analysis. Mean and Standard deviation were used to test the research questions while Analysis of Variance (ANOVA) was used to test the research hypotheses.

RESULTS AND DISCUSSION

Research question 1:

What are the mean achievement scores of students taught chemistry using instructional material and those taught without instructional material?

Table 1**:** Mean scores and standard deviations of students taught with no Instructional materials (control group) and those taught with instructional materials (experimental group).

Group	Mean	Std. Deviation	N
Control (without Instructional materials)	15.61	2.09	20
Experimental (with Instructional materials)	18.08	1.57	

The Table **1** above indicates that the mean score of the control group is obtained to be 15.61, and the standard deviation 2.09 differs appreciably with that obtained in the experimental group, that is 18.08 (mean score) and 1.57 (standard deviation). The mean difference of the two groups is 2.47, slightly differing with 6.51 obtained from research of Ibe et al. [3] on the ground of the number of

students used. This means that the treatments have a positive effect in the experimental group, indicating that students taught chemistry using instructional material had better achievements in chemistry than those taught without instructional material, and this assertion is consistent with the statements made by Enohuean [18] and Ibe et al. [3] from their works.

Research question 2:

What are the mean achievement scores of male and female students taught using instructional material and those without the use of instructional materials, as measured by Chemistry Achievement Test (CAT)?

Table 2: Mean Scores and Standard deviations of Male and Female Students taught with no Instructional Materials (Control group) and those taught with Instructional Materials (experimental group).

Gender	Group	Mean	Standard Deviation	N
Male	Control	15.9	1.66	10
	Experimental	18.28	1.41	
Female	Control	15.33	2.43	
	Experimental	17.88	1.71	

Table 2 showed that male students obtained a mean score of 15.9 and standard deviation of 1.66 for the control group while for the experimental group, the mean score of 18.28 and standard deviation 1.41 were obtained. Also the female students obtained a mean of 15.33 and standard deviation 2.43 for the control group while for the experimental group, the mean score of 17.88 and standard deviation of 1.71 were obtained. The mean differences of the treatment sets (experimental and control groups for male and female students) are 2.38 and 2.55, respectively. The overall average mean score when instructional materials are employed in teaching for both male and female students is 0.40. This means that there is slight positive improvement in the mean achievements of the male

students taught with Instructional materials when compared to that of the female students. This statement is consistent with the statement by Ibe et al. [3] from their research that the male students achieve more (with average mean retention score of 2.23) in chemistry than their female counterparts

$H0_1$: There is no significant difference between the mean achievement scores of students taught chemistry using instructional materials (experimental group) and those taught without instructional materials (control group).

Table 3: Control and experimental (without and with instructional materials) groups

Group	Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Control	Between Groups	6.038	3	2.013	.451	.717
	Within Groups	338.950	76	4.460		
	Total	344.988	79			
Experimental	Between Groups	5.650	3	1.883	.754	.524
	Within Groups	189.900	76	2.499		
	Total	195.550	79			

From Table 3 above, for the control groups, the computed level of significance (0.717) was found higher than 0.524 obtained in the experimental group (students taught with instructional materials) which is closer to 0.05 set for the study. And generally, both levels of significance were greater than the 0.05 level of significance set for the study. Therefore, by decision rule, the researcher rejects the null hypothesis ($H0_1$) and concludes that there is significant difference between the mean

achievement scores of students taught chemistry using instructional material and those taught without instructional material.

$H0_2$: There is no significant difference on the mean academic achievement scores in gender amongst students taught chemistry by incorporating instructional materials as measured by Chemistry Achievement Test (CAT) and those taught without instructional materials.

Table 4: Control group (without instructional materials)

Groups	Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Control (male)	Between Groups	5.400	3	1.800	.634	.598
	Within Groups	102.200	36	2.839		
	Total	107.600	39			
Experimental (male)	Between Groups	4.075	3	1.358	.662	.581
	Within Groups	73.900	36	2.053		
	Total	77.975	39			
Control (female)	Between Groups	1.475	3	.492	.077	.972
	Within Groups	229.300	36	6.369		
	Total	230.775	39			
Experimental (female)	Between Groups	1.875	3	.625	.200	.896
	Within Groups	112.500	36	3.125		
	Total	114.375	39			

Table 4 showed the computed level of significance for male control and experimental group were obtained to be 0.598 and 0.561 respectively. Also, that the computed level of significance for female control and experimental group were obtained to be 0.972 and 0.896 respectively.

The computed level of significance obtained for experimental groups in both male and female treatments (that is 0.561 and 0.896 respectively) were lower and closer to 0.05 set for the study than that obtained in the control groups of male and female treatments (that is 0.598 and 0.972 respectively).

Again, since the level of significance obtained in male treatment group (control and experimental) were found to be lower than that obtained in their female counterparts, and both treatments (male and female groups) had greater level of computed significance when compared to the 0.05 level of significance set for the study, the researchers therefore rejects the null hypothesis ($H0_2$) and conclude that there is significance difference on the mean achievement scores on gender amongst students taught chemistry by incorporating instructional materials as measured by the Chemistry Achievement Test (CAT) and those taught without instructional materials.

Therefore, chemistry being basically a practical science, the activity of teaching the subject to the students should be experimentally undertaken with instructional materials to enable the students have better cognitive and academic achievements in the subject, as the instructional materials also quicken and make effective the learning process through activation of the five sense organs in real time [24].

The findings from this work revealed that instructional materials had a great positive influence on academic achievement of secondary students in Chemistry; that is, those taught with instructional material perform better in Chemistry Achievement Test than those taught without instructional materials [3, 18, 25, 26]. Also, that male students perform better than their female counterparts in the same Chemistry Achievement Test under the same condition, and this finding is consistent with the work of Ibe et al. [3] but differs with the work of the Aniodoh and Egbo [24] and

the reason may be attributed to the external factors such as personal and emotional dispositions of the female students.

CONCLUSION

To improve the academic achievement of students in chemistry in Enugu State, there is need for teachers to employ instructional materials during teaching, as shown by this study. Effective use of instructional materials, classroom control and management methods may be employed by the instructor in order to carry both male and female students along and overcome the failure of students, prevalent in chemistry test and examination.

5RECOMMENDATIONS

From the research work, the researchers recommend that:

Teachers in the field should adopt the use of instructional materials in teaching chemistry.

1. Effective use of instructional materials, classroom control and management methods may be employed by the instructor to carry the students along for adequate concentration during learning process.
2. Teachers should work more closely with the female gender for the improvement of the female students' academic achievement as they are mostly affected by emotional factors that are capable of affecting their academic achievement.
3. Education board in Enugu State and non-governmental agencies on education should support secondary schools with provision of chemistry instructional materials.
4. More research should be carried out at a broader level using different approaches in order to obtain a wider overview of the results.

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CONFLICT OF INTEREST
The authors wish to declare that there is no conflict of interest arising in regards to the publication of the this work.

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