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Effects Of Mathemagenic Activities And The Learning Of Chemistry By Secondary School Students In Ondo State, Nigeria.

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Abstract: *The study investigated the effects of mathemagenic activities on students' learning in Chemistry instructions in senior secondary schools in Akoko South Local Government Area of Ondo State, Nigeria. The study adopted the quasi-experimental design of the pre-test and post-test control groups. Two hundred and seventy senior secondary class 11 Chemistry students constituted the sample. One hypothesis was generated for the study and tested using Analysis of Covariance, Multiple Classification Analysis of Variance, and Scheffee's Post-Hoc Test of Multiple Comparison statistics were employed in analyzing the data at 0.05 level of the significance. The results showed that mathemagenic activities enhanced better performance on students' learning tasks, encourage and generate their interest towards the learning of Chemistry. Chemistry teachers should consciously enhance their instructional process by incorporating relevant mathemagenic activities into their teaching.*

Key Words*: Activities, Chemistry, Effect, Mathemagenic, Learning.*

I. Introduction

Over the years, many changes have been made in the contents of secondary schools Chemistry curriculum and also in its implementation/teaching particularly in the Nigerian setting. The review of science curriculum for Nigeria high schools was precipitated by assumed inadequacies in what existed before 1968. The new science syllabus which came into being claimed to reflect international trends (Science Teachers' Association of Nigeria 1971; Comparative Education Study Adaptation Centre, 1972). In particular, the Chemistry aspects of the Nigerian secondary school science project emphasized quantitative work in the belief that the use of facts and figures are necessary for better understanding of scientific concepts and principles. In spite of this development, quantitative areas of Chemistry are still found difficult and sometimes never understood by the secondary school students (Azumi, 2008,Akalonu, Dachung and Yero, 2006 and Mari 2008). That a concept is difficult does not make it out rightly, un-teachable or un-learnable. This concern stems from the facts Chemistry students should devote more time to some study activities.

Educators are concerned with attempts to encourage and popularized the use of carefully planned instructional strategies and models. An important type of activity that can achieve the purpose of helping students to learn and study volumetric concept in Chemistry effectively is mathemagenic activity (Orimogunje, 2012). It is a way of helping students to study the learning materials in a logical step by steps sequence, by the use of instructional objectives and adjunct questions in text. Thus, students develop skills in manageable portion. By being actively involved in learning and checking their responses, and gauge their progress (Rothkopt, 2009). Mathemagenic activity as defined by Rothkopf (1970) implies those students' activities that are relevant to the achievement of specified instructional objectives in specified situation or places. These activities include the use of adjunct questions in text, instructional objectives, advance organizer, post-organizer, reading, and note-taking e. t .c. According to Gagne in (1985) if learning is to occur, the materials must stimulate the recall of prior learning. As well, the learning materials should be related to the existing cognitive structure of the students. The use of instructional objectives as pre- instructional strategies or mathemagenic activities is based on the assumption that if learners were told what is expected of them, they will learn more effectively simplify the stimulus environment and reduces the number of irrelevant bits of information that impinge on their learning activities.

Questioning is an important teaching skill which takes up a sizeable percentage of teaching time. During teaching, questions are asked by teachers to reveal to the students the kind of thinking which is expected of them. This enable the learner to review what he has learnt, the review could be in form of simple recall of information, interpretation of the ideas picked from the learning materials. Rothkopf (1982) and Kolawole (2001) illustrated that when the learning materials are interspersed with questions on the materials, learners can maintain their attention at a relatively high level for long period of time. The interspersed questions prompt learners to process the materials in a manner that is more likely to give birth to learning.

Several empirical studies have been carries out in Europe, America and Nigeria to show the usefulness and impact of mathemagenic activity in teaching and learning (Fraser, 1970; Ausubel, 1980; Rothkopf, 2009 and Orimogunje, 2011).Some of these researches has been seen somehow covert-mathemagenic activities, however, little efforts have been directed towards the use of instructional objectives and adjunct questions in text as overt-mathemagenic activities. According to Herron in 1971,overt-mathemagenic activities are observable skills that can be control or manipulated by specific design attributes of instruction such as inserted questions in a text in programme learning. These mathemagenic activities also demand that students must exhibits some degree of independence study skills especially in the area of volumetric concept in Chemistry. For instance, the students must understand the technicalities involves in volumetric analysis (Acid/Base reactions). These attributes cannot be acquired in Chemistry classes where students are taught using lecture method only. Hence, there is need to pay attention to the learner's role in translating instructive information into internal representation called overt-mathemagenic activities. This study intend to find out how instructional objectives and adjunct questions in text could use so as to minimize some of the limitations and increases the probability of learners' involvement more replicable, predictable and efficient in the learning of volumetric analysis.

1.1 PURPOSE OF THE STUDY

The purpose of this study is to investigate the effectiveness of instructional objectives, and adjunct questions in text when used as mathemagenic activities in secondary schools Chemistry instructions in Ondo State, Nigeria.

1.2 RESEARCH QUESTION

What are the effects of instructional objectives and adjunct questions in text, and the combined mode of instructions on students' performance in volumetric analysis?

1.3RESEARCH HYPOTHESIS

There is no significant difference in the academic performance of Chemistry students who used instructional objectives, adjunct questions in text, and combined mode as mathemagenic activities in the learning of volumetric analysis.

II. Methodology

This study adopted the pre-test and post-test control quasi- experiment design. The population for the study comprised all the Chemistry students in all the secondary schools in Ondo State, Nigeria. Two hundred and seventy senior secondary class II Chemistry students in Akoko South Local Government Area of Ondo State constituted the sample. Purposive sampling technique was used to select the sample schools based on some criteria such as, school with well-equipped library, well-stocked with Chemistry textbooks and professionally qualified and experienced chemistry teachers. The chemistry achievement texts (pre-test and post-test) were made up of 35 items based on both cognitive and verbal domain of the learning materials. This instrument was given to test expert who critically assessed it for content validity and ensured that all the test items were related to the content in the textual materials under study. The reliability of the instrument was tested using Kuder Richardson formula (K_{20}) and a reliability coefficient of 0.83 was obtained. The recommended learning materials were sent to WAEC/SSCE/NECO examiners to examine the instructional objectives and adjunct questions in text raised and determine their suitability in relation to the contents to be learned in the classroom setting.

2.1 Mode of Instructions

Instructional Objectives in text and Adjunct questions in Text.

2.2 Objective

To make students use the instructional objectives and adjunct questions in studying volumetric concept in Chemistry text.

2.3 Materials

Chemistry text book, student's practical note-books, volumetric apparatus and reagents.

2.4 Procedure

Teacher's Activities/Students' Activities

- Teacher describes the conception of mass/volume relationship.
- Student re-describes the conception in the light of teacher's description.
- Teacher discusses the task/ goal to be achieved and ask the students to study the objectives carefully.
- Students use instructional objectives in studied the assigned text,
- Teacher instructs students to study the various sizes of volumetric apparatus and reagent through the text and pose questions on the difficult task.

- Students recognize types of volumetric apparatus and their uses.
- Teacher asks for any words/terms that are not properly understood. He keeps them to the content of the text in his explanation.
- Students further ask questions on difficult concepts where necessary.
- Teacher demonstrates by given examples on how to handle the volumetric apparatus with care to avoid damages.
- Students develop self-confidence by handing the various apparatus and reagents in the light of teacher's description.
- Teacher instructs students to re-read the text and solves some problems to ensure whether the task goal has been achieved.
- Students carryout some practical activities in order to achieve the expected goal.
- Teacher collects the practical note-book at the end of lesson; he assesses the students' responses and effect corrections.
- Students modify actions in the light of teacher's feedback. They also discuss more difficult activities with their teacher.

The post-test (CAT) was administered to the students to detect whether the expected objectives have been achieved. The data collected were analyzed using mean, standard deviation, ANCOVA, MCA and Scheffe's Post-Hoc Multiple range comparison.

III. Results And Discussion

3.1 Question

What are the effects of mathemagenic activities on students' performance in volumetric analysis?

To answer in this question, the performances of the students in the pre-test and post-test score were compared. The comparison of the data is presented below

TABLE I: Comparison of pre-test, post-test, mean scores and standard Deviation of the students performance.

GROUP	N	Pre-test mean	SD	Post-test Mean	SD
Texts + IQs	90	7.17	2.27	16.56	4.24
Texts + AQs	90	7.00	2.93	18.02	4.39
Texts+ IO_S + AQ_s	90	6.92	3.12	19.54	4.03

Table I shows the mean pre-test scores of 7.17, 7.00,6.92, and the post-test scores of 16.56,18.02,19.54 for experimental groups respectively. This reveals that these groups were quite homogenous at the point of commencement. In order words, the background knowledge of the students in all the study groups were relatively equal and low. Besides, at the post-test stage, there was a substantial difference in the level of students' academic performance after treatments. Hence, mathemagenic activities could be said to have substantially improved the performance of students in Chemistry.

3.2 HYPOTHESIS

There is no significant difference in the academic performance of Chemistry students who used instructional objectives and adjunct questions in text on students' performance in volumetric analysis.

In testing this hypothesis, the post-test scores of those students in the experimental groups were subjected to analysis of covariates (ANCOVA), in which the pre-test scores were used as covariates. The result of the ANCOVA is presented in table ii below.

TABLE II: ANACOVA showing the Academic performance of students who were exposed to mathemagenic activities.

Source	SS	Df	MSS	F_{cal}	F_{table}
Covariate(pre – test	443.588	1	443.588	17.32	3.84
Group	430.834	2	215.417	13.27	2.60
Error	4318.912	266	16.237		
Collected total	5164.552	269			
Total	93041.000	270			

$P< 0.05$

Table II shows that F_{cal}(13.27) was greater than F_{table} (2.60) at 0.05 levels of significance. This implies that significant difference existed between the scores of students exposed to the experimental treatments groups in respect of their performance towards practical lesson in volumetric analysis. This result could be attributed to the various treatments given to each experimental group. Thus, the hypothesis was rejected.
To further ascertain the pair of group that is significantly different at 0.05 alpha levels, Scheffee's post-Hoc multiple range comparison tests among the groups was carried out. The results are presented in table iii below.

TABLE III: t-Test pair-Wise comparison of post-test scores of experimental groups.

Groups		Mean	E1	E2	E3
Text + IOS	E1	16.56			*
Text + AQS	E2	18.02			
Text + IOS + AQS	E3	19.54			

The mean difference is significant at 0.05 levels.

TABLE III shows a post-test mean distribution of 16.56 for instructional objective treatment group, 18.02 for adjunct questions treatment group, and 19.54 for combined mode of instruction treatment group respectively. Scheffee's post-Hoc Test also show that significant difference existed between the performances of those students exposed to instructional objectives groups (E1) and combined mode of instructional groups (E3). The result collaborated rejection of the Null hypothesis.
The data was further subjected to Multiple Classifications Analysis of Variance (MCA) of Post-Test Chemistry Achievement Test (CAT) as presented on table IV below.

TABLE IV: MUTIPLE CLASSIFICATION ANALYSES OF VARIANCE (MCA) FOR EXPERIMENTAL GROUPS
Grand Mean= 18.04

Variable + category Treatment	N	Unadjusted deviation	Eta	Adjusted independent + covariates Deviation	Adjusted post test mean	Beta
IQ_S	90	-1.48		-1.54	16.50	
AQ_S	90	0.02	.423	-0.01	18.03	.28
IQ_S+AQ_S	90	1.50		1.55	19.59	
R						.28
R^2						0.078

In table IV, with the grand mean score of 18.04 students exposed to the three experimental groups had adjusted post test mean scores of 16.50, 18.03 and 19.59 respectively. This indicates that students in IQ_S +AQ_S group perform best in Chemistry Achievement Test (CAT) followed by AQ_S and IQ_S respectively. The coefficient of multiple correlations R is 0.28; this shows that the relationship between the treatments and CAT was low and positive. The coefficient of determine R^2 was 0.078. This implies that 7.8% variation in pre-test CAT score was accounted for by the variation in post-test CAT. In order words, the remaining 92.2% variation in post-test CAT was due to the treatment given by the researcher.

3.4 DISCUSSION

This study aimed at determined the superiority of the pedagogical modes to which experimental subjects were exposed. It was established that the presence of either instructional objectives or adjunct question or a combination of the two cues could serve a useful purpose in learning Chemistry concepts, comparatively, however, adjunct questions seemed to shows the greater beneficial effects on learning of Chemistry concepts. Although, instructional objectives in text proved helpful and this had been demonstrated in previous studies as reported by Olowojaiye,(2001); Olarewaju (1992) and Rothkopf, (1982).

IV. Conclusion And Recommendations

` It is observed that when textual materials are presented with useful pedagogical aids such as instructional objectives and adjunct questions in text. This would facilitate students' independent study as well as enhance group instruction in the classroom situation, resulting in greater involvement of students' activities. Chemistry teachers need to enhance the instructional process by deliberately incorporating the use of mathemagenic activities of instructional objectives and adjunct question in text into the teaching process. For instant, in giving students a reading assignment from their textbook, the teacher could construct performance objectives and adjunct questions, supply these to students and instruct them on how to use these aids in their

reading. Evaluation of the assignment could then be based on the specified objectives with the guide of the adjunct questions

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