An Assessment of The Effects of Problem Solving Instructional Strategies on Students' Achievement and Retention in Chemistry with Respect to Location in Rivers State

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Abstract: The main purpose of this study is to determine how problem solving instructional strategies would affect students' achievement and retention in Chemistry with particular reference to River State. A pre-test, post-test, non-equivalent control group design was adopted. Two research questions and two hypotheses were respectively answered and tested. Purposive and stratified random sampling was used to select 428 SS II students from two rural and two urban local government areas of Rivers State. These students were randomly assigned to the two treatment groups. Problem solving with Model and Feedback – Correctives (PF), Problem solving with Model Only (PM), and the control Problem Solving by The Conventional Method (PC). The model used is a Generic Problem Solving Inquiry Model developed by Hungerford (1975). A researcher developed and moderated instrument, Chemistry Achievement Test (CAT) and lesson plans were used for the study. Data collected were analyzed using Mean, Standard Deviation (SD) and some gains of achievement and retention and that the hierarchical order of achievement is PF, PM and PC. No significant differences were observed in the post-test mean scores of urban and rural subjects in the achievement is PF, PM and PC. No significant differences were observed in the post-test mean scores of urban and rural subjects in the achievement and retention tests administered in the course of the study. Based on the findings, it is recommended that both rural and urban Chemistry teachers use problem solving instructional strategies, particularly that in which use of a model is supplemented with feedback-correctives in teaching.

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1. Introduction

Researchers on students' output in Science and Technology reflect poor performance (Okebukola, 1986). The several identified problems include low morale and poor preparation of teachers, over crowded classroom/inadequacy of laboratory and workshop facilities, poor attitude of students to work, gross under funding and inadequacy of rewards for excellence in science teaching and learning among others. As multi-dimensional as the problems associated with this trend are, the issue of emerging result-oriented delivery system appears to occupy a conspicuous position (Olaiyiwola, 2002). In an attempt to ensure purposeful/results oriented science delivery in schools, strategies such as activity oriented, guided-inquiry, cooperative learning, demonstration, humanistic, think and do, modified lecturer and many others have been employed by science teachers. Okebukola (1986, 1987), Ajewole (1991), Otuka (1991), Nwosu (1991), Akubuilo (2004) and Ojo (1992) did several works on cooperative learning, discovery/expository instructional methods, laboratory, think and do, acquisition and development of process skills and classroom interaction patterns respectively. These are good reference point to the above observation. However, the specific problem of teaching science in urban and rural environments and whether urban students perform significantly better than their rural counter-parts when specific strategies are used have not been adequately investigated.

In recent times, however, government at various levels had been making concerted efforts to improve life in rural areas. The educational system is not let out; hence various education management commissions to ensure that qualified specialist teachers are sent to rural schools have adopted various policies. These efforts by the government notwithstanding, secondary schools in rural areas appear to be disadvantaged in comparison with their urban counter-parts. The fact is that most rural secondary schools are comparatively younger and are not as well established as most urban secondary schools. Furthermore, teachers are known to prefer postings in urban than in rural schools.

It has been concluded many times both descriptively and experimentally that there is lack of direct teaching of problem solving strategies in our schools; (Bello, 1985, Akubuilo 1995); that students need practice in order to utilize the method effectively and that science teachers approve of this method in theory not in practice (Ndu, 1991). In spite of the established needs for use of problem solving in teaching basic sciences, literature on problem solving instructional strategies in Chemistry seem to be scanty in the Nigerian context, most especially in ascertaining the level of performance with respect to urban and rural locations of schools. This study therefore utilized three problem solving instructional strategies – problem solving with model and with feedback – corrective (PF), problem solving with model only (PM), and problem solving by the conventional method (PC) in a bid to determine the effects of these strategies on cognitive achievement and retention of urban and rural students in Chemistry.

1.1 Purpose of the study

i. To determine the effect of problem solving instructional strategies on students' achievement and retention in Chemistry with respect to location.

ii. To ascertain if significant differences exist in the achievement and retention means scores of urban and rural students taught by the various problem solving strategies.

1.2 Research Questions

1. What are the relative effects of problem solving instructional strategies (PF, PM and PC) on Students' Achievement in Chemistry with respect to location as determined by the Chemistry Achievement Test (CAT)?
2. What are the relative effects of problem solving instructional strategies (PF, PM and PC) on students' retention in chemistry with respect to location as determined by the Retention Test in Chemistry?

1.3 Research Hypotheses

The following hypotheses guided this study:

HO_1: There is no statistically significant difference in the post-test Chemistry achievement mean scores of urban and rural subjects taught Chemistry respectively by PF, PM and PC, as measured by the Chemistry Achievement Test (CAT)?

HO_2: There is no statistically significant difference in the Chemistry Retention mean scores of urban and rural subjects taught Chemistry respectively by PF, PM and PC as measured by the Retention Tests in CAT.

2. Method

2.1 Design

The study is quasi-experimental, employing the Pre-test, Post-test non-equivalent control group design. There was no randomization of subjects in the study. Intact classes were randomly assigned to the experimental and the control groups respectively.

2.2 Sample and Sampling Techniques

The sample consisted of 428 SS II students from twelve intact classes, sampled randomly from four senior secondary schools in Obio/Akpor and Port Harcourt Local Government areas and from Omuma and Tai Local Government areas of Rivers State. Both purposive and stratified random sampling techniques were employed in drawing the sample.

Initially, purposive sampling was used in drawing the participating secondary schools. This was because the investigator decided to use schools with at least three classes of SS II. To increase the representativeness of the sample, the method of stratified random sampling was applied. The population studied was stratified into two groups or strata (male and female), thereby excluding the co-educational schools. The schools in each stratum were further grouped into urban and rural. A male and female school each from the urban and rural sub-stratum was randomly sampled by simple balloting by replacement. Four schools altogether emerged, two all males and two all females schools.

2.3 Administration of the Instruments

The research conditions (treatment and control) was for a period of eight weeks, after which all subjects were given a pre-test, then the research condition were given a post-test.

The PF and PM groups were instructed by the trained teachers using the appropriate teaching techniques mapped out for each group. For this group, the study adopted "Generic Problem Solving Inquiry Model developed by Hungerford (1975). This instructional model outlines the typical steps one goes through in the scientific solution of a problem. It identified seventeen sequential students behaviours and twenty-one corresponding teacher behaviours groups into a six-stage model of problem solving. For the PF group, feedback – correctives, which focused on reinforcing students' thinking and correcting technical errors, were additionally given. Students in the PC group (the control group) were not exposed to the problem-solving model in use. They were taught by the conventional method of problem solving instruction in Chemistry (which involved providing tasks to be performed without any set procedures).

2.4 Data Collection

The instrument for data collection was a teacher-made Achievement Test on Chemistry (CAT). This test was a forty-item test consisting of three subsections of remembering, understanding and thinking. These subsections were developed to correspond to the knowledge, comprehension, application, analysis, synthesis and evaluation cognitive levels. It is a five-option multiple-choice objective test with items from the sections of Chemistry selected for the study. These sections are separation techniques, hardness in water, cracking alkanes to produce alkenes, fractional distillation of crude oil. The instrument was used for both the pretest, post-test and retention test. However, the post-test which was administered a day after the six weeks teaching was a disguised version of the pretest. The retention test was administered two weeks after the experiment. The internal consistency coefficient of CAT was established at 0.76. The temporal stability estimate of CAT was also established since it was to be used as retention test.

Lesson plans were prepared and used in teaching the two treatment groups (PF and PM) and the control (PC). The lesson plans in each of the cases reflected the instructional pattern mapped out for use. So three versions for the lesson plans drawn from each of the Chemistry contents were prepared and validated. The lesson notes served as models for teachers used in the study. However, training was provided for teachers used for the treatment groups.

2.5 Data Analysis

Data for the study were analyzed using mean, Standard Deviations (SD) and Analysis of Covariance (ANCOVA). The mean scores of students in urban and rural schools were respectively calculated for each of the three groups (PF, PM and PC) in achievement and retention tests in CAT. This was used to answer the research questions. Analysis of Covariance (ANCOVA) was used to test the hypothesis in the study. Pretest scores were used as covariates, thus serving to adjust for the initial differences between and within groups.

3.Results

The results of the analysis are presented in the tables below according to the research questions and hypotheses of the study. All the hypotheses were tested at the 0.05 level of significance.

Research Question 1

What are the relative effects of Problem Solving Instructional Strategies (PF, PM and PC) on Students' Achievement in Chemistry with respect to location as determined by the Chemistry Achievement Test (CAT)?

This research question were answered using data in Table 1:

Table 1: Pre-test and Post-test Mean Achievement and Standard deviations (SD) scores of Subjects in CAT with respect to Strategy and Location

Strategy	**Types of test**	**Location**			
		Urban		Rural	
		Mean	S.D	Mean	S.D
PF	Pre-Test	24.23	8.81	23.67	6.91
	Post-Test	67.27	11.37	66.64	8.13
PM	Pre-Test	24.87	11.18	25.43	9.95
	Post-Test	59.69	11.20	58.61	11.91
PC	Pre-Test	26.01	10.68	25.77	8.58
	Post-Test	55.78	12.03	55.61	10.54

Results in Table 1 reveal that the pretest mean achievement scores in BAT are much lower than the post-test mean scores in all the groups for both urban and rural subjects. This is because the pre-test-treatment-post-test design was adopted. Based on this observation the subjects in both urban and rural schools made some gains in achievement and for both groups the hierarchical order of achievement is PF, PM and PC.

Hypothesis 1

There is no statistically significant difference in the post-test Chemistry achievement mean scores of urban and rural subjects taught Chemistry respectively by PF, PM and PC, as measured by the Chemistry Achievement Test (CAT).

This hypothesis were tested using data in Table II.

Table II: Two-way ANCOVA of Experimental and Control Subjects Achievement in CAT due to Strategy and Location

Source of Variation	Sum of squares	DF	Mean squares	F	Table F	Remark
Covariate	36383.207	1	36383.207	1023.154	3.86	S
Pretest	36383.207	1	36383.207	1023.154	3.86	S
Main Effects	12675.750	3	4225.250	118.821	2.62	S
Strategy	12674.563	2	6337.281	178.214	3.02	S
Location	0.593	1	0.593	0.017	3.86	NS
Interaction						
Strategy X	198.956	2				
Location			9.478	2.797	3.02	NS
Explained	44146.195	6	7359.699	206.910	2.12	S
Residual	14970.707	421	35.560			
Total	59116.902	427	138.447			

Results in table II showed that there is no significant difference in the post-test mean scores of urban and rural subjects in the Chemistry achievement tests. The null hypothesis is therefore accepted as stated.

Table III: Mean Retention and Standard Deviations (SD) Scores of the Subjects with respect to Strategy and Location in Chemistry Retention Test

Strategy	Location			
	Urban		Rural	
	Mean	S.D	Mean	S.D
PF	65.35	8.73	63.3	8.22
PM	54.72	11.63	53.07	12.09
PC	48.19	12.75	47.36	11.77
	56.08	11.04	54.58	10.69

The mean retention and standard deviations scores were calculated for the groups (PF, PM and PC) using Chemistry Retention Test scores of subjects in urban and rural schools. The data reveal that the mean retention score was highest for the PF strategy, followed by the PM and least with the PC for both urban and rural locating.

Hypothesis II: There is no statistically significant difference in the Chemistry Retention mean scores of urban and rural subjects taught chemistry respectively by PF, PM and PC as measured by the Retention Tests in CAT.

Data in Table IV were used to test this hypothesis.

Table IV: Two-way ANCOVA of Experimental and Control Subjects' Performances in Chemistry Retention Test Due to Strategy and location

Source of Variation	Sum of squares	DF	Mean squares	F	Table F	Remark
Covariate	38133.801	1	38133.801	1226.917	3.86	S
Pretest	38133.801	1	38133.801	1226.917	3.86	S
Main Effects	4132.742	3	1377.581	44.322	2.62	S
Strategy	4117.957	2	2058.979	66.246	3.02	S

Location	8.030	1	8.030	0.258	3.86	NS
Two-way Interaction	55.256	2	27.628	0.889	3.02	NS
Strategy X Location	55.256	2	27.628	0.889	3.02	NS
Explained	58313.469	6	9718.910	312.696	2.12	S
Residual	13085.094	421	31.081			
Total	71398.563	427	167.210			

In table IV showed that there is no significant difference in the post-test mean scores of urban and rural subjects in the retention tests in CAT with respect to location. Therefore, the null hypothesis case is accepted as stated.

4. Discussion

The no significant different in the achievement of students due to location observed shows that students' achievement in chemistry is not dependent on the type of environment under which teaching takes place. There is uniform level of cognitive achievement for urban and rural students. This finding agrees with those of Ekpo (1986) and Fakunle (1986) while it disagrees with those of Okeke and Wood-Robinson (1980) who found significant difference between urban and rural subjects.

In retention test, (table IV) location was not significant. Also the interaction (strategy X location) is not significant. This shows that both urban and rural subjects in the PF, PM and PC groups retained similarly. The implication is that problem solving strategies (innovative or conventional), whether for urban or rural subjects aid retention, probably because problem solving is an activity method of teaching. This finding is in line with those of Tenebaum (1986) and Okebukola (1986), which asserted that any instructional mode, which elicits adequate students participation, has a profound effect on students' retention.

5. Conclusions

From the findings of this study, chemistry teachers in both urban and rural schools should use activity methods such as problem solving instructional strategies. Problem solving instructional strategies, which result in improved cognitive development, acquisition of skills and retention of subject matter learnt could lead to improved cognitive development, acquisition of skills and retention of subject matter learnt could lead to improved attitude towards solving life problems. These are required to enhance functionality in our education system. Chemistry curriculum should also be structured to aid teaching through problem solving.

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