Relative Effects of Selected Instructional Strategies in the Preparation of Science Students for the Solution of Energy Depletion Problems

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Abstract
This study was undertaken to sensitize science educators on the need to begin to prepare the young ones in the solution of energy depletion problems. It reveals the best strategy for preparing the young ones in the solution of energy depletion problems in science classrooms. The study was carried out in junior secondary schools in Delta State Nigeria. The population of this study was all junior secondary two pupils enrolled in public secondary schools in Delta State. Four randomly selected public schools each of which has at least four arms were randomly selected from Oshimili south local government area in the state. Four instructional strategies, of which one was used as the control group, were employed by four instructors, who were trained on the instructional strategies and were randomly assigned to the four groups. Intact classes were used. The Energy Achievement Test (EAT) was constructed by the researcher and administered as pre test, immediate post test and a follow- up (retention) test. Data was analyzed using ANCOVA. It was discovered that in the pre test the computer aided video group was disadvantaged in terms of initial background, while the concept mapping group did better in the immediate post test. The VD group did better in the retention test than the other groups, even though the ANCOVA did not show any significant difference at 0.05 level. In terms of location, the urban schools proved significantly better than the rural schools in terms of initial background, immediate post test and in the retention test. Consequently, computer aided video was recommended as the best strategy since it helps in retention. However, the CM is recommended for immediate achievement. This study is of immense benefit to basic education students and the future generation who will witness the depletion of finite energy sources.

Keywords: *Energy; Depletion; Renewable; Instructional Strategies.*

Introduction

Scientists in different parts of the world and in different generations have conceded that our major sources of energy: coal, oil, natural gas and uranium are finite and non renewable. However, energy and its sources will remain indispensable to man. The importance of energy sources can be better appreciated if we know that their absence will mean absence of electricity, living a primitive type of life and there will be no vehicles and aero planes. Furthermore, there shall be shortage of food due to subsistence farming while energy and other forms of research will be absent. Being that these energy sources will run out at some time in the future, possibly in the life time of the present Junior Secondary school students, it has become imperative for their generation to come up with solutions: practical, clean and economically viable forms of energy (Hagan 2012). At the current rate, the world uranium reserves will be depleted by 2070, coal
2080, natural gas and petroleum 2050 while other oil reserves will be depleted by 2040 (Grunwald Report, 2010/2011). This implies that by 2080 all known finite energy resources will likely be gone. Science teachers and students are acquainted and are concerned with varieties of strategies that facilitate learning (Obi, 2014; Obi and Attah, 2014). Some nations use audio-visual presentations that are integrated with other modes of instruction to sensitize their young ones. In a recent study 76% of teachers reported that they use digital media and down load TV and Video content, 82% reported that digital media is more effective when integrated with other instructional resources. 66% reported that it increases motivation, 62% reported that it helps teachers to be more effective. In spite of numerous procedures adopted by different nations of the world the best procedures to prepare and sensitize future scientists to come up with solutions and alternative energy sources are yet to be ascertained.

Statement of the Problem

Energy depletion and its adverse consequences has become a topical issue in science literatures and conferences at both local and international levels. Many developed nations of the world have thought

it worthwhile to sensitize and prepare their young ones against future energy crises. Unfortunately, in many African nations the adults seem to be uniformed about the impending danger let alone the young ones. Furthermore, there seem to be no recommended strategies for preparing our future scientists or the younger generation against the impending dangers even when scientific findings have shown that the younger generation will be most vulnerable to energy crises if nothing is done to get them prepared. With this understanding, this study was undertaken to determine the relative effects of selected strategies in the preparation future scientists against energy crises. The issues at stake now are: which instructional strategies will be better for sensitizing and preparing future scientists against energy depletion. Will computer aid audio visual presentations be more effective when integrated with other modes of instruction in the preparation of science students for the solution of energy problems? Will mere advocacy and concept mapping be more effective? Will schematic visual maps of energy systems be more effective than other instructional strategies?

Research Questions

In order to investigate these problems, the following research questions have been formulated to guide the study:

1. Is there any difference in the pre instructional mean scores of students in the four instructional classes?
2. Is there any difference in the post instructional mean scores of students in the four instructional classes?
3. Is there any difference in the post achievement mean scores of urban and rural schools?
4. Is there any difference in the follow-up mean achievement test scores of students?

Hypotheses

The following hypotheses have been formulated:

Ho_1: There is no significant difference in the post achievement test scores in the Energy Achievement Test (EAT) among students in the four instructional classes.

Ho_2: There is no significant difference in the post achievement test scores of students in EAT between urban and rural schools.

Ho_3: There is no interaction effect of instructional strategies and the location of schools on the achievement of students.

Ho_4: There is no significant difference in the follow-up (retention) EAT scores among students in the four instructional classes.

Ho_5: There is no significant difference in the follow-up (retention) EAT scores of students of urban and rural schools.

Ho_6: There is no interaction effects of instructional strategies, location of school (urban or rural) and students' retention in the follow-up EAT scores.

Delimitation of the Study

The study was confined to government secondary schools in Oshimili south local government of Delta State, Nigeria. The findings of the study might not be used to explain causes of poor performance. Furthermore; it may not be used to generalize to all Secondary Schools, since the students have different social background.

Assumption of the Study

The study was based on the assumption that the sensitization, creativity and achievement of students in energy related problems depend on the strategy or method of instruction adopted. Furthermore, it assumed that a combination of various methods with class discussion and other forms of interaction are indispensable during instruction.

Methodology

This is a quasi-experimental study which was carried out in phases. The first being the training of instructors on four instructional strategies: Combination of computer aided audio-visual presentations (VD) with questions, combination of Concept Mapping (CM) with discussion, combination of discussion with Visual Maps (VM) and combination of Traditional Lecture Method (LM) with discussion. The second was the development of measuring instrument known as the Energy Achievement Test (EAT), which consists of the; pre-test, post-test and the followup (retention) test. The last stage was classroom instruction was done using intact classes.

The study was carried out in junior secondary schools in Oshimili local government area of Delta State. The population of this study was all junior secondary two students enrolled in public secondary schools in Delta State. Four randomly selected public schools each of which has at least four arms were randomly selected from the local government areas in the state. Four instructional strategies, of which one was used for the control, were employed by four instructors, who were trained on the instructional strategies and were randomly assigned to the four groups. Each instructional class was exposed to pre-test, post-test and the follow up test which were administered before, immediately at the end of two-month instruction, and three months after administering the post test respectively. Intact classes were used and data were analyzed using the analysis of covariance (ANCOVA). In other words, the study employed a 2x4 factorial design using pretests, posttests and delayed posttests, as well as four instructional groups, namely: Concept mapping/discussion, computer aided audio-visual presentations, ordinary visual maps and lecture method/discussion. There were also two groups of students, consisting of those from rural schools and those from urban schools.

The population consists of all Junior Secondary School Students. A random sampling procedure was used to select four schools from a local Government area. Three schools were from the urban area while one school was from the rural area. The major independent variables of the study were the instructional strategies and the location of school (urban or rural) while the dependent variable was the achievement of students. The hypotheses were tested at the 0.05 level of significance, the pre-test was administered a week before instructional procedures, the post-test was administered one week after instruction while the delayed retention test was administered two months after the post-test, that is immediately they returned from their long vacation. The Energy Achievement Test (EAT) was constructed by the researchers and validated by experts in science education. The instruments consisted of thirty-four items whose reliability was tested using the split half method of computing coefficient of reliability. It was found to be highly reliable with coefficient of reliability r=0.83 which proved to be highly reliable.

Data Analyses

The two ways analysis of covariance (ANCOVA) was used to test the six hypotheses.

Hypotheses 1: There is no significant difference in the post achievement test scores in EAT among students in the four instructional classes.

Table 1: Comparison of performance gain as a result of instruction

Instructional Approach	N	Pre-Test Mean	Post-Test Mean	Mean Gain
CM	180	24.61	46.52	21.91
CAV	156	10.99	14.75	3.76
VM	161	31.54	38.60	7.06
LM	170	38.95	43.91	4.96

Table 1 shows the mean scores of subjects on the pre and post EAT as well as the mean gain in achievement. Mean gain of CM group method is higher followed by VM, then LM and CAV, respectively.

Table 2: Analysis of covariance (ANCOVA) of post EAT scores on Instructional strategies, Types of Schools and Interaction Effect

Source of Variation	Type III Sum of Squares	DF	Mean Square	F	Sig. F
Corrected Model	86698.605	8	10837.326	65.157	.000
Intercept	120830.601	1	120830.601	726.462	.000
Pre-Test	573.099	1	573.099	3.446	.064
Method	573.099	3	14318.233	86.085	.000
Location	4261.461	1	4261.461	25.621	.000
Method X Type	1590.718	3	530.239	3.188	.023
Error	109443.506	658			
Total	1176236.000	667			
Corrected Total	196142.111	666			

Table 2 shows the ANCOVA of post EAT scores on instructional strategy which indicates a significant difference among subjects in various groups (experimental and control). In this case, F=86.05 and P<.05 as a result Ho_1 which states that there is no significant difference in the post EAT scores of students is rejected since a significance difference exists. The post Hoc analysis of the immediate post-test using Sheffe test indicates that the concept map (CM) group was better followed by the Visual Map (VM), then the Lecture Method (LM) and last of all the Computer aided Video (CAV).

Hypothesis 2: There is no significant difference in the post achievement test scores of students in urban and rural schools. The mean scores of subjects in urban and rural schools are on table 3.

Table 3: Comparison of Post EAT Results of subjects in Urban and Rural Schools

Types of School	N	Mean	S.D
Urban	523	38.9120	17.39
Rural	144	36.229	16.188

Table 3 indicates that the urban schools have higher mean scores of 38.91 as against that of rural school of 36.23. Table 2 shows the ANCOVA of post EAT scores on location of school which indicates that a significant difference exists between urban and rural schools. Hence, Ho_2 is rejected.

Hypothesis 3: There is no interaction effect of instructional strategies and the location of schools on the achievement of students. Table 2 also indicates that an interaction effect exists. Hence, Ho_3 is rejected.

Hypothesis 4: There is no significant difference in the follow-up EAT scores among students in the three instructional classes.

The mean scores of subjects in the follow-up (EAT) are presented in table 4 which shows that the CAV is better than other methods in terms of retention.

Table 4: Comparison of the experimental and control group on the follow-up EAT measures

Instructional Approach	N	Post Test Mean	Follow-Up Post Test Mean Retention
CM	180	46.52	39.51
CAV	156	14.75	45.81
VM	161	38.60	44.47
LM	170	43.91	43.01
Location of School			
Urban	523	38.91	44.03
Rural	144	36.23	35.75

Table 4 shows that the urban schools are better while table2 indicates that a significant difference exists between urban and rural schools in the immediate post tests in favor of the urban schools.

Table 5: Analysis of covariance of follow-up Post EAT scores on Instructional Strategy, Type of School and Interaction Effects

Source of Variation	Type III Sum of Squares	DF	Mean Square	F	Sig. F
Corrected Model	9719.140	7	1388.449	5.366	.000
Intercept	593175.199	1	593175.199	2292.421	.000
Method	186.239	3	62.080	240	.869
Location	6161.782	1	6161.782	23.813	.000
Method X Location	1316.731	3	438.910	1.696	.167
Error	159910.528	618	258.755		
Total	1295672.000	626			
Corrected Total	16929.668	625			

Table 5 shows ANCOVA of (Retention) Follow-up Post EAT scores on instructional strategy, location of school and interaction effects. There is an indication that a significant difference does not exist among groups (F=240, P<.05). Hence $Ho_{4:}$ is accepted.

Hypothesis 5: There is no significant difference in the Follow-up EAT scores of students of Urban and Rural Schools.

Table 4 indicates that CAV is better in retention while table 5 indicates that a significant difference exists in terms of location of schools F=23.813 and P<.0.5. Hence Ho_5 is rejected.

Hypothesis 6: There is no Significant Interaction effects of Instructional Strategy and location of School (Urban and Rural) on students' retention in the Follow-up (EAT).

Table 5 indicates that interaction effect is not significant as F=1.696 and P>.05. Hence Ho_6 is accepted.

Discussion of Results

It was hypothesized that there will be no significant difference in the post achievement scores in EAT. However, the study found that a significant difference exists in favour of CM, VM, LM and CAV respectively. This is in agreement with other studies where significant difference exists in terms of methods of instruction. It is to be noted that the computer aided group (VD) was initially disadvantaged due to their low mean score in the pre-test which might have affected their score in the immediate post test. Other studies have also shown the advantages of concept map over many instructional strategies. However, there is an indication that the computer aided group proved better in retention in that they had higher mean score which however, was not statistically significant. But it is a great discovery to note that computer aided audio-visual instruction not only improve achievement and retention, but also correct the poor background of students and enable them to meet up with their counterparts who had a better background, and even over take them in delayed posttests. It is also clear that any of the methods can be combined with the discussion method to achieve the desired result of preparing students to enhance their achievements. It was hypothesized that there would be no significant difference between urban and rural schools in the immediate Post EAT and, in the follow-up, (Retention) EAT.

However, the study found that a significant difference exists between the rural and urban schools in the immediate post-tests in favour of the urban schools. This can be explained in terms of the disadvantage of rural schools where teachers are unwilling to go and teach the students, there by contributing to the poor back ground of the students and poor academic performance. Consequently, the major findings of the study are clear. There is a significant difference in the post achievement test scores in EAT among students in the four instructional classes in favor of Concept Mapping, followed by Visual Map, then Lecture Method and Computer aided Method when each of them is combined with discussion. There is no significant difference in the followup (Retention) EAT scores among students in the four instructional classes. However, the computer aided group showed significant improvement in that they did better by having a higher mean score in spite of their poor background.

There is a significant difference in the immediate post EAT scores between urban and rural schools in favor of the urban schools. There is a significant difference between rural and urban schools in the follow-up (Retention) EAT in favor of the urban schools. There is also interaction effects of location and methods of instruction in the immediate post-test of EAT and there is interaction effect of location and method of instruction in the follow-up (Retention) test in EAT. These however are in disagreement with Anikweze (1992), who found no significant interaction effects when teaching methods were compared. But the difference in result is understandable due to the different background of students as well as the difference in topics of instruction and personality of the teachers.

Conclusions and Recommendations

Based on the findings of the study, it is better to prepare science students to tackle energy related problems and avoid energy crises using Concept Mapping strategy to prepare the students for immediate achievement. However, it is better to prepare the students using the Computer aided video presentations in order to maintain a long-term gain and retention of what is learnt for easy application and solution of energy problems. In addition, any combination of the teaching strategies with discussions among students will equally lead to achievements and preparation of students against energy crises. The location of students affects the information they receive as well as their achievements. Consequently, most rural schools are disadvantaged in terms of immediate achievement and retention. Since Concept Mapping has been found to enhance achievement in EAT, it should be used in the preparation of an indigenous curriculum for solving energy problems. While the Computer aided Audio-Visual presentations are better for retention and should also be integrated into the indigenous curriculum for solving energy problems. Research efforts should be geared towards devising more strategies to prepare the young ones against future energy crises. Government should intensify efforts to bridge the gap between the rural and urban schools by ensuring that the essential infrastructures like water, good road networks and electricity, are provided to improve their learning environment and enhance their performance.

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