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Effects of Pictorial and Written Advance Organizers on Students' Achievement in Senior Secondary School Physics

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Abstract

This study investigated the effects of pictorial and written advance organizers on students' achievement in Senior Secondary School Physics. A total of 138 Senior Secondary Two (SS2) Physics students were involved in the study. A 3 x 2 factorial design was used for the study. From the findings, it was observed that advance organizers enhance the achievement and retention of the learning materials in Physics. On the whole, pictorial organizer was found to be more effective in facilitating students' achievement and retention in Physics than written organizer. The results also showed an insignificant difference existing between the achievement of male and female Physics students taught with pictorial and written organizers. Conclusion from findings led to the recommendation that teachers should be encouraged to adopt pictorial advance organizer in teaching the concept of heat energy in Physics.

Introduction

In scientific and technological development, Physics occupies a very crucial position. In Nigeria efforts are made towards encouraging more students to study Physics. However, previous studies tend to show that students' achievement in Physics is rather very low (Ivowi, 1997). Onwioduokit (1996) attributes this to insufficient manpower, lack of equipment, poor attitude of students and poor understanding of the concepts involved due to their 'difficult' nature. Other reasons are overloaded curriculum and ineffective teaching (Ivowi, 1997). It is therefore pertinent to look for variables that could be manipulated in order to find their effects on learning outcomes and to address the problems of teaching and learning of Physics in Senior Secondary Schools. Such variables that could be manipulated include advance organizer learning strategy (Akinbobola, 2004).

One instructional strategy, which probably has the potential to offer opportunity to address the problems of effective teaching and learning of Physics is the advance organizer learning theory advocated by Ausubel (1962). It can be an appropriate instructional approach to the teaching of concepts in Physics. Ausubel explains that advance organizer learning strategy is a pedagogic strategy for implementing the programme principles of progressive differentiation and integrative reconciliation which involves the use of appropriately relevant and inclusive materials that are maximally stable and discriminable from related conceptual systems in the learner's cognitive structure. It is used to provide a conceptual framework that students can use to clarify the task ahead. Meaningful learning is explained in terms of retention. Retention is the term used to denote the demonstration that learning has been maintained over time. It may be displayed through recognition or recall (Herron, 1994).

Coffey (2000) describes meaningful learning in terms of reception learning. By reception learning, Coffey means learning where the content of the learning task is presented to, rather than discovered by the learners. Meaningful reception learning involves the process of subsumption. Subsumption of information occurs when information enters a student's cognitive structure and interacts with and is subsumed under more inclusive concept already possessed by the student. Advance organizers work best when there is no prior knowledge involved because an advance organizer becomes the students' prior knowledge before learning the new material.

The advance organizer is a strategy in which the teacher helps students to make connections to new materials by highlighting the organizational and structural patterns of the new material and indicating how it relates to other materials already learned (Coffey, 2000). Advance organizers may

be presented as written text, as graphics organizer, may utilize audiovisual supports, or may be presented orally (Luten, Amos and Ackerson, 1980).

Statement of the Problem

Evidences of poor performance and declining enrolment point to the fact that the most desired technological, scientific and engineering application of Physics cannot be sustained. The implications consist in the fact that Physics teaching does not lead to students' understanding of concepts, functionality and application of its ideas, hence no learning.

This makes it imperative to search for an approach for teaching of Physics that aims at understanding rather than memorizing and juggling of facts. This study is therefore designed to find out the effects of pictorial and written advance organizers on the achievements of Senior Secondary School students in Physics and as a measure towards ensuring appreciable achievement and retention of learners in Physics learning.

Purpose of the Study

The purpose of this study is to investigate the effects of pictorial and written advance organizers on the achievement and retention of Senior Secondary School Students in Physics.

The study is designed to achieve the following objectives:

- (1) To investigate the extent to which the use of advance organizers (pictorial and written) will enhance the achievement of Physics students.
- (2) To examine the extent to which the use of advance organizers (pictorial and written) will enhance the retention of Physics students.
- (3) To compare the achievement of male and female Physics students taught with pictorial and written organizers.

Research Hypotheses

The following hypotheses were formulated and tested.

- Ho1: There is no significant difference in the achievement of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer.
- Ho2: There is no significant difference in the retention ability of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer.
- Ho3: There is no significant difference between the achievement of male and female Physics students taught with:
- (i) Pictorial organizer
 - (ii) Written organizer

Research Design

The research design adopted for this study was 3 x 2 factorial design. This shows three (3) levels of experimental factors and two (2) levels of gender.

Population

The population for the study was made up of all the SSII Physics students in the 12 co-educational secondary schools in Ife Central Local Government Area of Osun State. The size of the population was 1,164 Senior Secondary Two (SSII) Physics students.

Sample and Sampling Technique

A total of one hundred and thirty-eight (138) students took part in the study. Criterion – sampling technique was used to select schools from the target population. The criteria are:

- (i) Schools that have at least one graduate Physics teacher with at least three years of teaching experience.
- (ii) Schools that have well equipped and functional Physics laboratories.

Eight (8) schools met the above criteria. A random sampling technique, through the use of balloting was carried out to select three schools among those that met the above criteria. The three schools

were randomly assigned to treatment and control groups. Two (2) out of three (3) schools were used as experimental group while one (1) school was used as control group.

Instrument and Validation

A researcher made instrument, Physics Achievement Test (PAT) comprised of 50-multiple choice items in concept of heat transfer was used to gather data for the study. Validity of the items was assessed at the time the instrument was developed by three Physics teachers and two Physics experts. Items related to each instructional objective were selected for the instrument. The average difficulty and discrimination indices of PAT items were 0.59 and 0.50 respectively. The instrument was trial tested to establish reliability with 50 subjects in a school not selected to participate in the study. The Kuder Richardson coefficient of internal consistency for the instrument (PAT) was 0.86.

The pictorial organizer package was developed by the researcher and consisted of various maps, picture and charts related to the concept of energy in terms of forms of energy, source of energy, conversions of energy and applications of energy conversion, which served as subsumer for the learning of heat transfer.

The written organizer package consisted of the same contents with pictorial organizer but was presented in written form.

Research Procedure

In order to account for possible pre-existing differences in overall ability between the groups, pretest was administered to two groups and the results were used as covariate measures. In order to control for the teacher quality variable, both groups were taught by the research assistants (Physics teachers in each school). The research assistants were trained and they were also provided with detailed instructions and well articulated lesson packages on the concept of heat transfer. The experimental group 1 was taught with pictorial organizer while the experimental group 2 was taught with written organizer. The control group was taught without advance organizers. The experimental and control groups were taught the concept of heat transfer using the same content outline for four weeks. The posttest was administered to the two groups after the treatment. Three weeks after posttest, retention test was administered to the two groups

Methods of Data Analysis

The data collected were analyzed using t-test, Analysis of Covariance (ANCOVA) using pretest scores as covariates and multiple correlation analysis. All hypotheses were tested at .05 levels of significance.

Results

Hypothesis One (Ho1)

There is no significant difference in the achievement of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer.

The analysis is as shown on Table One.

Table 1: One-way Analysis of Covariance (ANCOVA) of Post-test Scores of students taught with pictorial organizer, written organizer and those not taught with advance organizer using pretest scores as covariates.

Source of Variation	SS	Df	MS	F	Decision at P<.05
Pretest		1	104.27	7.26	*
Main effects	104.27	2	1557.36	108.39	*
Explained	3114.73	3	1073.00	74.68	*
Residual	3219.00	134	14.37		
Total	1925.38	137	37.55		
	5144.38				

* = Significant at P<.05 alpha level

Critical F-value = 3.92

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Table 1 shows that the main effect was significant at $P < .05$. The calculated F-value 108.39 is greater than the critical F-value, 3.92, therefore the null hypothesis stating a non significant difference in the achievement of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer was rejected. Consequent upon the existence of significant difference in main effects, Multiple Classification Analysis (MCA) is considered to determine the specific contribution of the levels of advance organizers to the gain in students' achievement in Physics.

Table 2: Multiple Classification Analysis (MCA) of Posttest Scores of Students taught with Pictorial organizer, written organizer and those not taught with advance organizer.

Variable + Category	N	Unadjusted		Adjusted for independent variable and covariates	
		Dev'n	Eta	Dev'n	Beta
Advance Organizers			0.79		0.78
Pictorial Organizer	44	4.91		4.84	
Written Organizer	46	1.97		2.00	
Without Organizer	48	-6.39		-6.35	
Multiple R-Squared = 0.63					
Multiple R. = 0.79					

Table 2 shows a multiple regression index of $R = 0.79$ with a multiple regression squared index of $R^2 = 0.63$. This implies that 63% of the total variance in the achievement of students in Physics is attributable to the influence of advance organizers.

To find the order of effectiveness of advance organizers and direction of significance under investigation, the posttest scores were subjected to Scheffe multiple comparison test for a post hoc analysis as shown in Table 3.

Table 3: Results of Scheffe's Post hoc test for multiple comparison of advance organizers on students' achievement in Physics.

Dependent variable: POST-TEST						
(I) Advance Organizer	(J) Advance Organizer	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PO	WO	2.9368*	.801	.002	.9544	4.9191
	WAO	11.2955*	.793	.000	9.3334	13.2575
WO	PO	-2.9368*	.801	.002	-4.9191	-.9544
	WAO	8.3587*	.784	.000	6.4190	10.2983
WAO	PO	-11.2955*	.801	.000	-13.2575	-9.3334
	WO	-8.3587*	.784	.000	-10.2983	-6.4190

* The mean difference is significant at the 0.05 level

Where: PO = Pictorial Organizer
 WO = Written Organizer
 WAO = Without Advance Organizer

As shown in Table 3, the mean difference between PO and WO was 2.94, between PO and WAO was 11.30, and between WO and WAO was 8.36. This implies that pictorial organizer was the most effective in facilitating students' achievement in Physics. This was then followed by written organizer while the non advance organizer was seen to be least effective in facilitating students' achievement in Physics.

Hypothesis Two (H₀₂)

There is no significant difference in the retention ability of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer.

The analysis is as shown on Table Four.

Source of Variation	SS	Df	MS	F	Decision at P<.05
Pretest	186.17	1		30.57	*
Main effects	4692.69	2	186.17	385.29	*
Explained	4878.86	3	2346.35	267.05	*
Residual	816.05	134	1626.29		
Total	5694.91	137	6.09	41.57	

Table 4: One-way Analysis of Covariance (ANCOVA) of retention scores of students taught with pictorial organizer, written organizer and those not taught with advance organizer using pretest scores as covariates.

Table 4 shows that the retention ability main effect is significant at $P < .05$. The calculated F-value, 385.28 is greater than the critical F-value, 3.92, therefore the null hypothesis stating a non significant difference in the retention ability of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer was rejected. Consequent upon the existence of significant difference in main effects, Multiple Classification Analysis (MCA) is considered to determine the specific contribution of the levels of advance organizers to the ability to retain materials taught.

Table 5: Multiple Classification Analysis (MCA) of retention scores of students taught with Pictorial organizer, written organizer and those not taught with advance organizer.

Grand Mean = 35.79	N	Unadjusted		Adjusted for Independent Variable and Covariates	
Variable + Category		Dev'n	Eta	Dev'n	Beta
Advance Organizers			0.92		0.91
Pictorial Organizer	44	5.14		5.02	
Written Organizer	46	3.47		3.51	
Without Organizer	48	-8.04		-7.97	
Multiple R.Squared = 0.86					
Multiple R. = 0.93					

Table 5 shows a multiple regression index of $R = 0.93$ with a multiple regression squared index of $R^2 = 0.86$. This implies that 86% of the total variance in the retention of materials taught by Physics students is attributable to the influence of advance organizers.

To find the order of effectiveness of advance organizers and direction of significance under investigation, the retention scores were subjected to Scheffe multiple comparison test for a post hoc analysis as shown in Table Six.

Table 6: Results of Scheffe's Post hoc test for multiple comparison of advance organizers on students' retention ability in Physics.

Dependent variable: RETENTION SCORES						
(I) Advance Organizer	(J) Advance Organizer	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PO	WO	1.6790*	.538	.009	.3434	2.9995
	WAO	13.1818*	.531	.000	11.8669	14.4968
WO	PO	-1.6709*	.538	.009	-2.9995	-.3434
	WAO	11.5109*	.525	.000	10.2109	12.8108
WAO	PO	-13.1818*	.531	.000	-14.4968	-11.8669
	WO	-11.5109*	.525	.000	-12.8108	-10.2109

* The mean difference is significant at the 0.05 level

Where: PO = Pictorial Organizer

WO = Written Organizer

WAO = Without Advance Organizer

As shown in Table 6, the mean difference between PO and WO was 1.67, between PO and WAO was 13.18, and between WO and WAO was 11.51. This implies that pictorial organizer was the most effective in facilitating students' achievement in Physics. This was then followed by written organizer while the non advance organizer was seen to be least effective in facilitating students' retention in Physics.

Hypothesis Three (Ho3)

Ho3 (i): There is no significant difference between the achievement of male and female Physics students taught with pictorial organizer. The analysis is as shown on Table Seven.

Table 7: t-test comparison of posttest mean score on achievement of male and female Physics students taught with pictorial organizer.

GENDER	N	\bar{X}	SD	DF	t- Calculated	t- Critical	Decision at P<.05
Male	20	40.95	2.37	42	0.30	2.01	NS
Female	24	40.71	2.87				

NS = Not significant at P<.05

The analysis in Table 7 shows that the calculated t-value, 0.30, is less than the critical t-value, 2.01, at P<.05. Therefore, the null hypothesis stating a non-significant difference between the achievement of male and female Physics students taught with pictorial organizer was retained.

Ho3(ii): There is no significant difference between the achievement of male and female Physics students taught with written organizer. The analysis is as shown on Table Eight.

Table 8: t-test comparison of posttest mean scores on achievement of male and female Physics students taught with written organizer.

GENDER	N	\bar{X}	SD	DF	t- Calculated	t- Critical	Decision at P<.05
Male	22	39.14	2.68	44	0.49	2.01	NS
Female	24	38.75	2.67				

NS = Not significant at P<.05

The analysis in Table 8 shows that the calculated t-value, 0.49, is less than the critical t-value, 2.01, at $P < .05$. Therefore, the null hypothesis stating a non-significant difference between the achievement of male and female Physics students taught with written organizer was retained.

Discussion of Results

The results of hypothesis one showed that a significant difference was found to exist among the achievement of Physics students taught with pictorial organizer, written organizer and those not taught with advance organizer. The post hoc analysis as shown in Table 3 indicated that pictorial organizer was found to be most facilitating, followed by written organizer and non-advance organizer was the least in enhancing students achievement in Physics. This might have been due to the stability and clarity of the anchoring ideas that the organizer provided in the cognitive structure of the experimental group of Physics students. This study is in line with the finding of Kang (1996) that advance organizer enhances students' performances and facilitate meaningful learning.

The results of hypothesis two showed that a significant difference was found to exist among students taught with pictorial organizer, written organizer and those not taught with advance organizer with respect to their ability to retain materials taught. The post hoc analysis as shown in Table 6 also indicated that pictorial organizer was found to be most facilitating, followed by written organizer and non advance organizer was the least in enhancing students' retention in Physics. This might be due to the fact that advance organizer seemed to make students to remember more conceptual ideas and were able to relate the test to prior knowledge. This was consistent with the findings of Mayer and Bromage (1980) that advance organizers facilitated meaningful learning and retention of Physics concepts.

The results of hypothesis three showed that there was no significant difference between the achievement of male and female Physics students taught with pictorial and written organizers. The non-significant difference in the achievement of male and female Physics students is in line with the finding of Nsofor (2001). He observed that both males and females could do well in science if exposed to similar learning conditions.

Conclusion

On the basis of the findings in this study, the following conclusions were drawn:

- (1) Pictorial organizer is more effective in enhancing students' achievement and retention in Physics than written organizer.
- (2) Physics students taught with advance organizers performed better than those not taught with advance organizers.
- (3) There exists no significant difference between the achievement of male and female Physics students taught with pictorial and written organizers.

Recommendations

Based on the results of the study, the following recommendations were made:

- (1) Physics teachers should adopt the use of pictorial organizer in teaching the concepts of heat energy in Physics.
- (2) Textbook authors should adopt the advance organizers strategy in presenting materials in their books.
- (3) Seminars/Workshops should be organized for Physics teachers to appraise them with the use of advance organizers.

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