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Effects of Use of Advance Organizers on Students' Performance and Retention of the Concepts of Electromagnetism

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ABSTRACT

The study investigated the effects of Pictorial, written and verbal advance organizers on student's performance and retention of the concepts of electromagnetism. A total of 200 students comprising of 108 females and 92 males of Senior Secondary School two (SS2) physics students were involved in the study. The study adopted a pretest-post test control design. From the findings it was observed that the Pictorial Advance Organizers (PAO) is most facilitating in enhancing the performance and Retention of concepts in electromagnetism. No significant difference existed between the mathematical abilities of students taught using the advance organizers and those taught without advance organizers in their performances on the concepts of electromagnetism. Based on the conclusion of this study it is recommended that teachers should be encouraged to make use of Pictorial Advance Organizer (PAO) in teaching the concepts of electromagnetism, irrespective of student's mathematical ability, in order to improve on their performance and retention of electromagnetism.

Keywords: Advance Organizers, Mathematical Ability, Electromagnetism, Retention.

INTRODUCTION

Physics has occupied a very crucial position in scientific and technological developments hence efforts are being made especially in Nigeria, towards encouraging more students in studying Physics. A great deal of effort and major resources are devoted to physics instruction. Modeling of method for high school instruction have been developed by wells, Hestenes and Swackhamer (1994) in which the traditional lecture-demonstration approach was abandoned in favour of the student-centered inquiry approach based on

the learning cycle popularized by Robert Karplus. The major reason according to their research interest is to adopt an approach to help students develop a more coherent, flexible, and systematic understanding of Physics. Such approaches include schematic modeling for meaningful learning (Halloun, 1996), problem solving techniques (Metes, 1981; Ahiakwo, 1988; Ahiakwo & Okey 2009; Ashmore, 1979), Use of advance organizers (Onwioduokit & Abimboloola, 2005), among others.

One instructional strategy which probably has a potential to offer opportunity to address the problems of effective teaching and learning of physics is the advance organizer, according to Onwoduokit and Abimboloola (2005). Advance organizers can be useful for teaching concepts in physics. It is a learning strategy for implementing the programmes 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 (Asubel, 1962).

Amasuomo and Obomanu (2003) utilized Advance Organizers to improve instruction and performance in technological instructions. The use of this advance organizer strategy has improved Physics students' achievement using pictorial and written advance organizers (Abimboloola and Onwoduokit (2005), mainly, to bring about meaningful learning. Meaningful learning According to Ausubel (1962) is explained in terms of retention of concepts. Kooy, Skok and McLaughlin (1992) stated that students with or without disabilities improve their learning and retention of new skills and concepts when educators use advance organizers. Most Physical and conceptual models put forward for solving problems in physics may not have identified algorithm for solving numerical problems, students mathematical ability come to bear in both numerical data organization, solution and prediction of physical behavior and properties.

Students at the secondary school level have poor mathematical knowledge which has affected immensely their thoroughness in identifying physical quantities, relationship between them and ability to use mathematics knowledge to translate the physical relationships shown in the problem state. Tuminaro & Redish (nd) asserted that Physics students who lacked basic Algebra, performed

poorly on mathematical problems solving tasks in Physics. Furthermore, Adeyemi (2007) in his study of mathematics as language for involving secondary school children in science and technology indicated that their performance in SSCE mathematics correlated with their performance in SSCE physics and are generally poor while Igbokwe (2003) highlighted on intricate link existing between mathematics, science and technology and maintains that without mathematics there will be no science, and without science, no technology.

Gabriel (2006) research on Physics student cognitive preferences in electromagnetism reveals low achievement, partly due to the abstractness of the concept. It is the concern of recent research to rethink on pedagogical strategies that would motivate learning and aid retention of concepts. The advance organizers are presented as written, graphical, may be with audiovisual supports, or maybe presented orally, (Luiten, Amos and Ackerson, 1980). Categorically, the advance organizers adopted in the present study is the pictorial (2-demensional graphics), written and verbal organizer.

STATEMENT OF THE PROBLEM

The decline in the performance of students in Physics are responsible for the declining enrolment in professional and technological courses such as Engineering, Medicine, Architecture, Geography, Integrated science, Science education, Physics and Mathematics. Besides, the present conventional pedagogical approach in teaching and learning of Physics adopted by most teachers has not improved the students understanding, performance and retention of physics concepts. In recent times Physics Phobia has captivated the interest of learners and reduced enrolment for the subject. It is therefore the intent of this research to investigate whether the use of advance organizers would improve student's performance, mathematical abilities to solve problems and retention of the concepts of electromagnetism.

PURPOSE OF THE STUDY

The purpose of the study is to investigate the effects of advance organizers on student's performance, on the concepts of electromagnetism. The study is designed to achieve the following objectives:

- To investigate the extent to which the use of advance

organizer (Pictorial, written and verbal) will enhance the performance of students in electromagnetism.

- To examine the effects of use of advance organizers (Pictorial, written and verbal) on the performance of students in electromagnetism, given their mathematical abilities.

- To evaluate the effects of use of advance organizers (Pictorial, written and verbal) on students' retention of the concepts of electromagnetism

RESEARCH QUESTIONS

The following research questions were stated to guide this study.

a. How does the use of advance organizers enhance the performance of students in electromagnetism?

b. What are the effects of use of advance organizers on the performance of students in the concepts of electromagnetism given their mathematical abilities?

c. To what extent does the use of the advance organizers contribute to the retention of the concepts of electromagnetism, among the students?

RESEARCH HYPOTHESES

The following research null hypotheses were formulated to guide the study.

HO_1: There is no significant difference between the performance of students presented with advance organizers and those without advance organizers in the concepts of electromagnetism.

HO_2: There is no significant different between the performances of students presented with advance organizers and those without advance organizers in learning the concepts of electromagnetism, given their mathematical abilities.

HO_3: There is no significant difference between the retention of students presented with advance organizers and those without advance organizers in the concepts of electromagnetism.

RESEARCH DESIGN

The research design adopted for this study was a quasi-experimental design of the pre-test, post-test control type.

POPULATION OF THE STUDY

The population for the study was made up of all the SSII physics students in the $14c^0$-educational secondary schools in Obio-Akpor Local Government Area of Rivers State. The size of the population was 1040 Senior Secondary School Two (SSII) physics students.

SAMPLE AND SAMPLING TECHNIQUES

A sample of 200 students comprising of 108 females and 92 males from 4 schools purposively selected. The criteria for selection are:

a. Schools that is co-educational, having sufficient equipped laboratory which is adequate for teaching of the concepts of electromagnetism.

b. Schools having qualified graduate Physics teachers.

c. Schools where the concept of electromagnetism have not been taught in SSII.

d. Schools comparable in terms of their performances in West African school certificate examination on Physics for at least four years (2009-2012) as shown in the table 1

Table 1: Comparability of Performance in Physics (SSCE) Sample Schools.

Schools	No. of Students (entry)	No. of Passes Al -C6	No. of Passes D7-E8	No. of Failure (F9)	% Pass	% fail
I	190	72	59	59	68.95	31.05
II	170	117	46	7	95.88	4.12
III	221	171	26	23	87.23	12.26
IV	208	105	80	23	90.24	9.76
Total	**789**	**465 (58.94%)**	**211 (26.74%)**	**112 (14.19)**	**85.58**	**14.29**

Instrument and validation

The instruments used for this study is the Physics Performance Test on Electromagnetism (PPTE) and the Mathematical Ability Test on Electromagnetism (MATEC) consisting of 50 multiple choice items each. The instruments were validated by three Physics teachers and an expert in science Education

(physics). The average difficulty indexes were 0.33 and 0.56 respectively. The instruments were trial-tested and their reliability coefficients of 0.74 and 0.99, estimated, respectively.

Research procedures

The PPTE and MATEC were administered as pre-test in order to measure their levels of performance in the concepts. The in-service teachers in the schools were trained as research assistants who taught the concepts using the advance organizers. Thus group 1 had pictorial advance organizers, group II had written advance organizers, and Group III had verbal advance organizers while the Group IV had no organizers but all groups taught equally using concept map strategy. At the end of the instruction, the PPTE (reshuffled) was administered as a post-test.

Methods of analysis:

The researcher used the mean, and percentage in answering the research questions while analysis of covariance (ANCOVA) was used for the test of hypothesis at 0.05 significant levels.

Results

Research question 1: How does the use of advance organizers enhance the performance of students in electromagnetism?

Table 2: Gain Scores of Students' Performance in the Concepts of Electromagnetism

Groups	Performance				
		$PPTE\ (pre)$ $\bar{x}$	$PPTE\ (post)$ $\bar{x}$	Gain	Gain%
Experimental	PAO	10.52	24.82	14.32	40.54
	WRAO	13.68	20.10	6.42	19.01
	VAO	12.86	23.86	11.00	29.96
Control	WAO	14.10	19.70	5.60	16.57

PrT - pre-test Post-test
PAO - Pictorial Advance Organizer
WRAO - Written Advance Organizer
WAO - Verbal Advance Organizer
WAO - Without Advance Organizer

Table 2 shows a differential gain score of students' performance in electromagnetism. Students taught using PAO scored 40.54% while those of WRAO had 19.01% and VAO, 29.96% in the experimental group while the control group, those

taught without advance organizer had 16.57%. The average performance of those in the experimental group is greater than the control group performance (29.836>16.57).

Research question II

What are the effects of use of advance organizers on the performance of students in the concepts of electromagnetism given their mathematical abilities?

Table 3: Gain scores of performance in electromagnetism by students of high, average and low mathematics abilities.

			Performance			
Groups		MA	$PPTE\ (pre)$ $\bar{x}$	$PTE\ (post)$ $\bar{x}$	Gain	Gain%
Experimental	PAO	H	9.88	23.88	14.00	41.47
		A	8.55	24.44	15.89	48.17
		L	10.93	23.73	12.80	36.93
	WRAO	H	12.75	22.00	9.25	26.62
		A	13.25	19.09	5.84	18.06
		L	12.86	20.14	7.28	22.06
	VAO	H	11.75	24.63	12.88	35.40
		A	12.87	24.00	11.13	30.59
		L	13.73	18.91	5.18	15.87
Contro —	WAO	H	16.14	22.29	6.15	16.00
		A	13.03	52.17	7.03	18.65
		L	15.27	19.55	4.28	12.29

MA- Mathematical Ability
H- High (24-34) A- Average (14-23)
L – low (4-13)
VAO- Verbal Advance Organizers
WAO- Without Advance Organizers
PAO- Pictorial Advance Organizers
WRAO- Written Advance Organizer

The performance of the students in the experimental group with high mathematical abilities is better than those of average and low mathematics ability irrespective of the organizer type and better than those in the control group. However, students of high and average mathematical abilities had high gain scores in their performance in the concept of electromagnetism when taught using the pictorial advance organizer, followed by those of the VAO and then the WRAO.

Research Question III

To what extent does the use of the Advance Organizers contribute to

the retention of concepts of electromagnetism among students?

Table 4: Delayed Post-test performance of students in electromagnetism

Groups	Performance				
		$\bar{x}$ $PPTE$ (pre)	$\bar{x}$ $PPTE$ $(post)$	Gain	Gain%
Experimental	PAO	10.50	24.80	24.69	69.94
	WRAO	13.68	19.64	5.96	17.89
	VAO	12.86	22.68	9.82	27.63
Control	WAO	14.10	17.26	3.16	10.08

PAO- Pictorial Advance Organizer
WRAO- Written Advance Organizer
VAO- Verbal Advance Organizer
WAO- Without Advance Organizer

Table 4 shows the retention levels of students based on their exposure to Advance Organizer types in learning the concepts of electromagnetism. The mean percentage gain of students presented with PAO is 69.94% while those of written advance organizer are 17.89%, but those presented with verbal advance organizer has 27.63%. These retention levels are greater than those of the control group of 10.08%. The implication is that pictorial advance organizer PAO has facilitated most in enhancing students' retention of the concepts of electromagnetism.

Test of Research Hypothesis
Hypothesis One

Ho1: There is no significant difference between the performance of students presented with advance organizers and those without advance organizers in the concepts of electromagnetism.

Table 5: Summary of Analysis of covariance of students' performance in electromagnetism based on the four instructional strategies using pre-test as a covariant

Corrected Model	724.876[a]	4	181.219	4.499	S
Intercept	9079.451	1	9079.451	225.429	S
PRETESTTO	0.021	1	0.021	0.001	Ns
Instructional strategies	668.453	3	222.818	5.532	S
Error	7853.879	195	40.276		
Total	105071.000	200			
Corrected Total	8578.755	199			
a. R Squared = .084 (Adjusted R Squared = 0.066)					

At 0.05 significant level and degree of freedom (df) 3,195, F-value is 5.532 against the critical value of 3.89. Since the F-calculated is greater than F-critical value (5.532>3.89). The null hypothesis is rejected. There is a significant different between the performance of students presented with pictorial, written and verbal advance organizers and those without the advance organizers in the concepts of electromagnetism.

Table 6: Post-hoc Analysis of students' performance in electromagnetism based on the four instructional strategies

Scheffe						
(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	4.4000*	1.26603	0.008	0.8299	7.9701
	3	0.7600	1.26603	0.948	-2.8101	4.3301
	4	3.8600*	1.26603	0.028	0.2899	7.4301
2	1	-4.4000*	1.26603	0.008	-7.9701	-0.8299
	3	-3.6400*	1.26603	0.044	-7.2101	-0.0699
	4	-0.5400	1.26603	0.980	-4.1101	3.0301
3	1	-0.7600	1.26603	0.948	-4.3301	2.8101
	2	3.6400*	1.26603	0.044	0.0699	7.2101
	4	3.1000	1.26603	0.116	-0.4701	6.6701
4	1	-3.8600*	1.26603	0.028	-7.4301	-0.2899
	2	0.5400	1.26603	0.980	-3.0301	4.1101
	3	-3.1000	1.26603	0.116	-6.6701	0.4701
Based on observed means. The error term is Mean Square(Error) = 40.071.						
*. The mean difference is significant at the .05 level.						

1-PAO 2-WRAO 3-VAO 4-WAO

Table 6.0 indicated the direction of significance using the pair wise comparison of the Scheffe's Post hoc analysis is that the Pictorial advance organizers (group I) contributed most to the significance of the effects of the instructional strategies on the performance of students in electromagnetism.

Hypothesis Two

Ho2: There is no significant difference between the performance of students presented with advance organizers and those without advance organizers in learning the concepts of electromagnetism.

Table 7: Summary of 4x3 Analysis of Covariance of students' performance, in the concept of electromagnetism classified by instructional strategies and mathematics abilities using pre-test scores as a covariant

Dependent Variable: PPTE POSTTEST(T)					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1091.966[a]	12	90.997	2.273	s
Intercept	8281.471	1	8281.471	206.849	s
PRETESTTO	0.114	1	0.114	.003	ns
Main Effect					
Instructional strategies	277.420	3	92.473	2.310	ns
MATA	124.080	2	62.040	1.550	ns
Interactions					
Instructional strategies * MATA	270.527	6	45.088	1.126	Ns
Error	7486.789	187	40.036		
Total	105071.000	200			
Corrected Total	8578.755	199			

Table 7 shows that at 0.05 significant level and df of 3,181, the F-ratio is 2.310 while F-theoretical is 2.65 since F-cal< F-critical, the null hypothesis is retained. There is no significant difference in performance between students taught with advance organizers and those without advance organizers in the concepts of electromagnetism, given their mathematical abilities.

Hypothesis Three

Ho3: there is no significant difference between the retention of students presented with advance organizers and those without advance organizers in the concepts of electromagnetism.

Table8: Summary of Analysis of covariance of students' retention of electromagnetism concepts based on the four instructional strategies using pre-test as a Covariant.

Dependent Variable: PPTE RETENTION(T)					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	532.741[a]	4	133.185	3.602	S
Intercept	8408.141	1	8408.141	227.400	S
PRETESTTO	1.366	1	1.366	0.037	Ns
Instructional strategies	502.125	3	167.375	4.527	S
Error	7210.134	195	36.975		
Total	99549.000	200			
Corrected Total	7742.875	199			
a. R Squared = .069 (Adjusted R Squared = .050)					

Shown on Table 8, the calculated $F_{3,195}$ value is 4.527 at degree of freedom of 3,195 and probability level of 0.05 against the $F_{3,195}$ critical value of 3.89. The calculated value is greater than the critical value hence the null hypothesis is rejected. This shows that there is a significant difference in the retention of electromagnetism concepts among the students presented with pictorial, written and verbal advance organizers and those not presented with advance organizers when taught using the concept mapping strategy. Table 9 shows that the Pictorial advance organizer contributed most to the retention of the concepts of electromagnetism.

Table 9: Post-hoc analysis of students' retention of the concept of electromagnetism based on the four instructional strategies

Multiple Comparisons							
PPTE RETENTION(T) Scheffe							
(I) GROUP	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
1	1	2	2.6200*	0.77203	0.011	0.4429	4.7971
		3	0.1000	0.77203	0.999	-2.0771	2.2771
		4	3.3000*	0.77203	0.001	1.1229	5.4771
2	2	1	-2.6200*	0.77203	0.011	-4.7971	-0.4429
		3	-2.5200*	0.77203	0.015	-4.6971	-0.3429
		4	0.6800	0.77203	0.855	-1.4971	2.8571
3	3	1	-0.1000	0.77203	0.999	-2.2771	2.0771
		2	2.5200*	0.77203	0.015	0.3429	4.6971
		4	3.2000*	0.77203	0.001	1.0229	5.3771
4	4	1	-3.3000*	0.77203	0.001	-5.4771	-1.1229
		2	-0.6800	0.77203	0.855	-2.8571	1.4971
		3	-3.2000*	0.77203	0.001	-5.3771	-1.0229
Based on observed means. The error term is Mean Square(Error) = 36.793.							
*. The mean difference is significant at the .05 level.							

1-PAO 2-WRAO 3-VAO 4-WAO

DISCUSSION OF RESULTS

The results of the research questions I, II and III indicates that the use of advance organizers immensely contributed to improved performance of students in the concepts of electromagnetism. This agrees with the views of Onwioduokit and Abimboloola (2005) Amasuomo and Obomanu (2003), and Ellis (2006) that graphic organizers make content easier to learn and understand as well as improve performance of learners in diverse content of studies in Physics and technology. Kooy, Skok and Mclaughin (1992) emphasized that students with or without disabilities improve their learning and retention of new skills and concepts when

educated with the use of advance organizers. This view agrees with the fact that Pictorial advance organizers promoted students interest and performance in this study. There is a significant difference between student's performance and retention of the concepts of electromagnetism when taught with advance organizers than those without advance organizers. No significant difference exists in the performance of students in the concepts of electromagnetism, given their mathematical abilities.

CONCLUSION

The following conclusions were drawn based on the findings of this study.

i. Pictorial Advance Organizers (PAO) is most facilitating in the performance and Retention of the concepts of electromagnetism.

ii. Mathematical abilities of students do not significantly affect their performance in electromagnetism.

RECOMMENDATIONS

Based on the result of this study, the following recommendations were made.

a. Physics teachers should adopt the use of Pictorial Advance organizers in teaching the concepts of electromagnetism.

b. Seminars and workshops for pedagogical change in teaching Physics should embrace use of advance organizer concept.

c. Textbook authors should include advance organizers in the presentation of concepts in Physics textbooks.

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