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Effects of Advance Organiser and Concept Attainment Models on the Achievement of Pre-Nce Students in Geometry in North – Central Nigeria

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Abstract
The study investigated the effectiveness of two instructional models – the Concept Attainment Model (CAM) and Advance Organiser Model (AOM) on the achievement of Pre-NCE students in geometry. Two research questions and three hypotheses guided the study. The design of the study was Pre-test Post-test equivalent control group design or quasi-experimental design. The study was carried out in Kogi and Benue States in the present North Central Nigeria. The population of the study was 1100 pre-NCE students in public colleges of education in the two states. Three out of the four public colleges of Education in the two states were randomly selected for the study. The total number of students in their intact classes who offered Pre-NCE geometry in these colleges was 830. This formed the sample for the study. 402 (48.4%) of the students were male and 428 (51.6%) were female. The instrument used for data collection was Pre-NCE Geometry Achievement Test (PNGAT). PNGAT had two versions – Pre-PNGAT and Post-PNGAT which were the same except for the swapping of some of the items. PNGAT was subjected to both face and content validation and item analysis. Using Kuder-Richardson (K-R) 20 formula, the internal consistency was found to be 0.74. Pre-PNGAT was administered on the groups before treatment started while Post-PNGAT was administered at the end of the 5-week treatment period. Scores from the Pre-PNGAT and Post-PNGAT were analysed using means and analysis of covariance (ANCOVA). Some of the major findings were (i) AOM and CAM were more effective than the conventional method (ii) CAM was more effective than AOM. Based on the findings, the implications were highlighted and recommendations were made towards better achievement of pre-NCE students in geometry.
Keywords: Avance organiser, concept attainment, achievement, Pre-NCE geometry

Introduction

Mathematics is one of the core subjects in primary and secondary school levels of education in Nigeria. Performance in mathematics at the Senior Secondary School Certificate Examination (SSSCE) is used to determine those who are qualified to enter the tertiary levels of education especially those taking courses in the sciences and science related disciplines like engineering, survey, medicine and so on.

In some colleges of education running Preliminary Nigeria Certificate in Education (Pre-NCE) programme, admission into the programme is through screening examination in which mathematics forms part of the examination. The NCE certificate is awarded by colleges of education on successful completion of a 3-year programme. It is the minimum teaching qualification in Nigeria for primary and junior secondary school levels of education (Federal Republic of Nigeria, FRN, 2004).

The Pre-NCE programme is a remedial outfit mounted by National Commission for Colleges of Education (NCCE) and run by some colleges of education. It is designed to reduce the deficiencies of candidates who either cannot make the required number of credit passes (including mathematics and English) at SSSCE for direct entry into the NCE programme or for candidates who have the required number of credit passes at SSSCE but cannot pass screening exercise for entry into the NCE programme. The Pre-NCE programme is for duration of one academic session. In summary, the programme is aimed at addressing the challenges of weak students in colleges of education (Junaid, 2008).

During the one year programme, students are exposed to prescribed number of courses that can remedy the deficiencies for entry into the NCE programme. Furthermore, following the recently introduced policy by the Joint Admissions and Matriculation Board (JAMB) that all Pre-NCE students must write the unified entrance examination, the Pre-NCE programme is saddled with additional responsibility of preparing the students in the various subject areas.

It is therefore clear that mathematics plays prominent role at all levels of education in general and the Pre-NCE programme in particular. But despite this role of mathematics, researches have shown that performance of students in the subject is generally poor (Okereke, 2006; Uloko and Usman 2007; Galadina and Yusha'u 2007). The scenario, certainly, is assuming alarming proportion resulting into a situation where more candidates opt for Pre-NCE programme than those going straight into NCE and degree programmes. As if the general poor

performance in mathematics is not worrisome enough, another dimension to the problem is students' performance in geometry, which is one of the major components of secondary school and Pre-NCE mathematics. Over the past two decades or so, the West African Examination Council (WAEC) has been disturbed about students' performance in geometry. WAEC (2000, 2003, and 2005) reported that students did not only perform poorly in geometry questions but avoided questions in geometry in certificate examinations. The worry heightened and assumed attitudinal dimension when WAEC (2005) reported that geometry is one of the topics in secondary school mathematics towards which students have shown negative attitude.

The situation at the Pre-NCE level is similar if not worse. This is obvious because, as has been noted earlier, the Pre-NCE is a representation of mainly weak students. The researchers have at various times taught geometry at the Pre-NCE classes. Over the years, the internal examination records have shown that students perform relatively poorly in geometry.

Educational researchers have attempted to probe into the causative factors of poor performance in mathematics in general and geometry in particular. Among the factors, poor quality of instructional techniques seems to be prominent (Ojo, 2002). The conventional method of teaching is still widely in use in schools despite criticisms against it as being teacher-centred.

Over the years, educational psychologists have been worried over all manner of instructional techniques many of which are teacher-centred and address only the cognitive behaviour of the learner at the expense of the affective and psychomotor domains. Among these psychologists are Jerome Bruner and David Paul Ausubel. From the theories of Bruner and Ausubel emerged the Concept Attainment Model (CAM) and the Advance Organiser Model (AOM) of teaching respectively as developed by Joyce and Weil (1980). Researches on these models (e.g. Chitriv, 1983, Sidhu and Singh, 2005; Padey, 1986; Keraro-Shihusa, 2005) have been done in India on the efficacy of the models. There is however inadequate documented information on research conducted in Nigeria on the effects of AOM and CAM in the teaching of mathematics in general and geometry in particular at the Pre-NCE level. This is what prompted the researchers to investigate the effects of these two models on the achievement of Pre-NCE students in geometry.

Research Questions

The study was guided by the following research questions:

1. What are mean achievement scores of students taught with CAM, AOM and conventional method?
2. What are the mean achievement scores of male and female students taught with CAM and AOM?

Hypothesis

At 5% probability level, the following null hypotheses were formulated to guide the study:

1) There is no significant difference in the mean achievement scores of students taught with CAM, AOM and conventional method.
2) There is no significant different in the mean achievement scores of male and female students taught with AOM and CAM.
3) There is no significant interaction effect of gender and instructional models on the achievement of students in Pre-NCE geometry.

Method

Design of the study

The study is quasi-experimental design. Specifically, it is a non-randomized pre-test post-test control group design. This design is considered appropriate for the study because the subjects in the sample were not randomly composed since they were given treatment in their intact classes to avoid disruption of the schools schedules during the experimental period (Ali, 2006).

Population of the Study

The population of the study was the entire Pre-NCE students in the four public colleges of education in Kogi and Benue States in North Central Nigeria who offered Pre-NCE geometry during the 2011/2012 academic session. The total number of these students in the four colleges was 1100.

Sample

The sample for the study was 830 Pre-NCE students in their intact classes who offered geometry during the 2011/2012 session from three out of the four public colleges of education in Benue and Kogi States. The three colleges of education were randomly selected through balloting. Balloting was also used to assign the three techniques of instruction – CAM, AOM and Conventional Method (CM) to the three sampled colleges.

Instrument for data collection

The instrument developed by the researchers for the collection of the data was pre-NCE Geometry Achievement Test (PNGAT). The PNGAT contained 30 multiple choice objective test items covering the content of Pre-NCE geometry. The topics were waited and assigned a number of items depending on scope and this was how the thirty items were arrived at. The PNGAT has two versions - Pre-PNGAT and Post-PNGAT. The Post-PNGAT is exactly the same as Pre-PNGAT except for the swapping of some of the items. The scores of Pre-PNGAT served as covariates to the scores of Post-PNGAT.

Validation of the instrument

A test blueprint was drawn during the construction of the items to ensure content validity. In addition, the test was face-validated by three specialists-two in mathematics education and one in measurement and evaluation. The items of the instrument were subjected to item analysis through a trial testing on an equivalent group of Pre-NCE students at the Federal College of Education, Okene, Nigeria. After modifications and retrials, the items were found to have difficulty indices of between 0.3 and 0.6 respectively and are therefore considered to be good since difficulty indices between 0.3 and 0.7 are realistically recommended (Anene and Ndubuisi, 2003). The items discrimination indices were found to be 0.25 and above and are therefore adjudged to be good because according to Ohuche and Akeje (1977), discrimination indices from 0.22 and above are recommended. The items' distractor indices were positive and therefore could be regarded as good items (Anene and Ndubuisi, 2003).

Reliability of the Instrument

After the validation of the instrument, it was trial-tested on an equivalent group of Pre-NCE students at the Federal College of Education, Okene. The scores were subjected to reliability test using Kuder-Richardson, K-R (20) formula and the internal consistency measure was found to be 0.74

Experimental Procedure

The following activities were carried out in the course of the experiment: Preparation of CAM and AOM lesson plans, training of research assistants, administration of Pre-PNGAT, administration of CAM, AOM and conventional method lessons, control of extraneous variables and administration of Post-PNGAT.

Method of data analysis

Data collated from the Pre-PNGAT, Post-PNGAT and retention test were analyzed according to the research questions and hypotheses. The mean scores were used to answer research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at $\alpha = 5\%$ probability level.

Results

The results of the analysis of the data are presented in the tables below based on the research questions and hypotheses.

Research question 1: What are the mean achievement scores of students taught with CAM, AOM and conventional method?

Table 1: Mean achievement scores of students taught with CAM, AOM and Conventional method

Groups		Pre PNGAT	Post PNGAT
CAM	N	274	274
	Mean	6.37	22.28
	Std. Deviation	2.68	3.13
AOM	N	256	256
	Mean	6.23	16.83
	Std. Deviation	2.04	2.99
Control	N	300	300
	Mean	5.59	12.15
	Std. Deviation	2.37	2.54

Table 1, shows that the Post PNGAT mean score of CAM group is 22.28 with standard deviation 3.13 and that of AOM group is 16.83 with standard deviation of 2.99 while that of control group is 12.15 with standard deviation of 2.54. It is therefore observed that the mean score of the CAM group is the highest followed by that of the AOM group.

Research question 2: What are the mean achievement scores of male and female students taught with CAM and AOM?

Table 2: Mean achievement scores of male and female students taught with CAM and AOM

Groups	Sex		Pre PNGAT	Post PNGAT
CAM	Male	N	118	118
		Mean	6.29	22.96
		Std. Deviation	2.51	2.84
	Female	N	156	156
		Mean	6.44	21.78
		Std. Deviation	2.81	3.26
AOM	Male	N	102	102
		Mean	6.14	16.80
		Std. Deviation	2.13	2.76
	Female	N	154	154
		Mean	6.29	16.85
		Std. Deviation	1.99	3.14

It is observed from Table 2 that for the CAM group, the mean achievement score for the male is 22.96 which is higher than the female mean achievement score of 21.78. For the AOM group, the mean achievement scores for male is 16.80 and 16.85 for the female. It is further observed that there are differences between the mean achievement scores of the CAM group and the AOM group in favour of the CAM group for both male and female.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught with CAM, AOM and Conventional Method

Table 3: Analysis of covariance (ANCOVA) for achievement difference between the mean scores of CAM, AOM and Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	14856.55	3	4952.18	615.34	0.000
Intercept	38009.42	1	38009.42	4722.90	0.000
PostTest	187.07	1	187.07	23.24	0.000
Group	13912.07	2	6956.04	864.33	0.000
Error	6647.56	826	0.05		
Total	259711.00	830			
Corrected Total	21504.11	829			

Table 3 shows that the F-value for the groups was found to be 864.33 with significance of F at 0.00. This means that at significant level of 0.05, the difference in the means is significant since 0.05 > 0.00, hence the null hypotheses is rejected. The Scheffe Post Hoe analysis is presented in table 4 below.

Table 4: Scheffe Post Hoc analysis for the groups

Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
PreTest	CAM	AOM	.30	.25	.47	-.30	.91
		Control	.98*	.24	.00	.40	1.56
	AOM	CAM	-.30	.25	.47	-.91	.30
		Control	.68*	.24	.02	.09	1.27
	Control	CAM	-.98*	.24	.00	-1.56	-.40
		AOM	-.68*	.24	.02	-1.27	-.09
PostTest	CAM	AOM	5.42*	.25	.00	4.81	6.03
		Control	10.12*	.24	.00	9.53	10.71
	AOM	CAM	-5.42*	.25	.00	-6.03	-4.81
		Control	4.70*	.25	.00	4.10	5.30
	Control	CAM	-10.12*	.24	.00	-10.71	-9.50
		AOM	-4.70*	.24	.00	-5.30	-4.10

*. The mean difference is significant at the 0.05 level

The multiple comparism analysis indicates that the difference between the mean achievement scores of the CAM group and the AOM group is significant in favour of the CAM group. The difference between the means of the CAM group and the control group is also significant in favour of the CAM group. Furthermore, the table shows that the difference between the means of the AOM group and the control group is significant in favour of the AOM group.

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students taught with CAM and AOM

Table 5: Analysis of covariance (ANCOVA) for achievement difference between the mean scores of CAM, AOM and conventional method groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	14856.55	3	4952.18	615.34	.000
Intercept	38009.42	1	38009.42	4722.90	.000
PreTest	187.07	1	187.07	23.24	.000
Groups	13912.07	2	6956.04	864.33	.000
Error	6647.56	826	8.05		
Total	259711.00	830			
Corrected Total	21504.11	829			

Table 5 above shows that the F-value for the groups was found to be 864.33 with significance of F at .00. This means that at significant level of .05, the difference in means is significant since .05 > .000 hence the null hypothesis is rejected. The Scheffe Post Hoc analysis is presented in table 6 below.

Table 6: Scheffe Post Hoc analysis of mean difference between male and female in the groups

Dependent Variable	(I) Sex	(J) Sex	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
PostTest	Male CAM	Female CAM	1.18*	.37	.02	.14	2.22
		Male AOM	6.15*	.41	.00	5.00	7.31
		Female AOM	6.11*	.379	.00	5.07	7.15
	Female CAM	Male CAM	-1.18*	.37	.02	-2.22	-.14
		Male AOM	4.97*	.39	.00	3.89	6.06
		Female AOM	4.92*	.34	.00	3.96	5.89
	Male AOM	Male CAM	-6.15*	.41	.00	-7.31	-5.00
		Female CAM	-4.97*	.39	.00	-6.06	-3.89
		Female AOM	-.05	.39	1.00	-1.13	1.04
	Female AOM	Male CAM	-6.11*	.37	.00	-7.15	-5.07
		Female CAM	-4.92*	.34	.00	-5.89	-3.96
		Male AOM	.05	.39	1.00	-1.04	1.13

*. The mean difference is significant at the 0.05 level.

The multiple comparison analysis as shown in table 6 above indicates that the mean difference between male CAM and female CAM is significant in favour of male CAM. Also the mean difference between male CAM and male AOM is significant in favour of male CAM and the mean difference between male CAM and female AOM is significant. The table further indicates that the mean difference between female CAM and male AOM is significant in favour of female CAM. Also the mean difference between female CAM and female AOM is significant in favour of female CAM. However, the table indicates that there is no significant difference in the mean scores of male AOM and female AOM.

Hypothesis 3: There is no significant interaction effect between gender and instructional models on the achievement of students.

Table 7: Analysis of covariance (ANCOVA) for the interaction effect between gender and instructional models

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15146.28[a]	6	2524.38	321.82	.00
Intercept	26656.88	1	26656.88	3.39	.00
PreTest	321.29	1	321.29	40.96	.00
Groups	13773.09	2	6886.55	877.94	.00
Sex	50.59	1	50.59	6.45	.01
Groups * Sex	53.51	2	26.76	3.41	.03
Error	6455.58	823	7.84		
Total	259741.00	830			
Corrected Total	21601.87	829			

Table 7 shows that the interaction effect between gender and the groups has an F-value of 3.41 with significance of F at .03. This means that at .05 level of significance, the interaction effect between gender and the instructional model is significant since .05 > .03, hence the null hypothesis is rejected.

Discussion of Results

The discussion of results is organized in the order of the research questions and hypotheses.

Research question 1 and hypothesis 1

The results in table 1 indicate that both the CAM and AOM groups have higher mean scores than the conventional method group while the CAM group has higher mean score than the AOM group. The differences in the mean scores were significant as shown in tables 3. Further test (Post Hoc) as shown in Table 4 revealed that while CAM and AOM are more effective than the conventional method, CAM is more effective than AOM. This finding agrees with Chitriv (1983) and Sidhu & Singh (2005) who discovered that Ausubel's and Bruner's strategies enhanced achievement in geometry compared to the conventional method. However, while Chitriv (1983) and Sidhu and Singh (2005) reported equal effectiveness of AOM and CAM, this study revealed that CAM is more effective than AOM. This study also agrees with Pandey (1986) that AOM is an effective instructional strategy when compared with the conventional method. The present finding further supports Keraro

& Shihusa (2005) on the effectiveness of AOM when compared with the conventional method.

The results as shown in table 2 indicate a difference in the mean achievement scores of male and female students in the CAM group in favour of the male. The difference in the mean scores of both male and female in the AOM group is marginal. The table further shows that the mean score of CAM group is higher than that of AOM group for both male and female. These differences in the means of the groups have been found to be statistically significant as shown in table 5. Further test (Post Hoc) as shown in Table 6 revealed that the mean difference between male CAM and female CAM is significant in favour of male. The mean difference between male CAM and male AOM is significant in favour of male CAM and the mean difference between male CAM and female AOM is significant in favour of male CAM. It is further revealed in the table that the mean difference between female CAM and male AOM is significant in favour of female CAM. However, the table revealed that there is no significant difference in the mean scores of male AOM and female AOM. It follows from these findings that CAM is generally more effective than AOM for both male and female. The result also shows that male achieve more than female using CAM, an indication that there is gender bias in using this instructional strategy. If this finding in the CAM group is juxtaposed with the result in the AOM group where there is no significant difference in the mean scores of male and female, we may tend to agree with Okigbo & Osuafor (2008) that type of instructional technique can close the gender gap in achievement in mathematics.

From table 7, it is evident that the interaction effect of gender and instructional models on achievement is significant. This is an indication that gender is a factor to reckon with in the choice of instructional techniques for enhanced achievement in Pre-NCE geometry. Put in another way, the effect of any of the two instructional models on the achievement of students depends on which of the two levels of gender it is applied to.

Conclusion

Teaching and learning and indeed achievement in Pre-NCE geometry can be enhanced through improved instructional techniques such as CAM and AOM. The study has therefore lent support to the growing pool of evidence from researches that instructional strategies are among the key variables that can improve achievement of students. The study has further lent support to some other research findings on gender to the effect that type of instructional techniques can close the gender gap in mathematics as has been established with the use of AOM.

Recommendations

Based on the findings of the study, the following recommendations are put forward.

1. Professional bodies such as Science Teachers Association of Nigeria (STAN) and Mathematical Association of Nigeria (MAN) should organise seminars and workshops on CAM and AOM to stimulate and popularise their use in schools, especially at the Pre-NCE level.
2. The use of CAM for instruction in Pre-NCE geometry should be given greater attention by the teacher because of its general effectiveness on achievement.
3. Models of teaching should form part of curriculum of National Teachers Institute (NTI), National Commission for Colleges of Education (NCCE), and National Universities Commission (NUC) for adequate teacher preparation on techniques of teaching.

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