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GRAPHICS AND STUDENTS' PERFORMANCE IN CHEMISTRY IN UYO
LOCAL GOVERNMENT AREA OF AKWA IBOM STATE

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ABSTRACT

This study on graphics and students' performance in Chemistry primarily aimed at examining the relative effectiveness of charts, diagrams and a combination of charts and diagrams in facilitating students' achievement in chemistry. Non-randomized-pretest-posttest-control group design was used. The sample consisted of 158 SS2 chemistry students (84 males and 74 females) in four intact classes in four randomly selected co-educational secondary schools in Uyo Local Government Area, Akwa Ibom State. A researcher developed Chemistry Achievement Test (CAT) with reliability coefficient of 0.76 was used in collecting data. The result of data analysis using mean scores and Analysis of Covariance (ANCOVA) showed that students taught using a combination of charts and diagrams had the best performance, followed by those taught using diagrams, charts, and without charts or diagrams on decreasing order. The interaction effect between treatment and gender was not statistically significant. Based on the observations made, it was recommended that chemistry teachers adopt a combination of charts and diagrams in teaching concepts in chemistry.

INTRODUCTION

The ultimate goal of any instructional process is to facilitate effective and meaningful learning. The persistent trend in students' poor performance, especially in the sciences, continues to disturb the parents, government, educators, psychologists and even the students (Ali & Anaekwe, 1997; Omole, 2002). With particular references to Chemistry, studies (Akpan, 1986) indicate that students rate it the second most difficult of the physical sciences. Among the factors indicted for this ugly trend are; conceptual demands (Eshiet, 1993), the curriculum (Eshiet, 1993), the student factor (Akpan, 2004), the teacher and the teaching factor (Akpan, 1986). Of these factors, the conceptual demands and teaching factor seem to be most significant.

The science of chemistry consists in the study of nature and behaviour of fundamental particles, which are themselves unobservable (Eshiet, 1993). In other words, chemistry deals with abstract concepts. Enhancing students' understanding of these concepts, nay, meaningful and effective learning requires effective use of appropriate instructional aids – the visuals and audio-visuals. According to Nkuehe (1995), these resources enable the teacher and the class to have easy and repeated reproduction of an event or procedure; provide visual access to a process or technique; provide a common framework of experiences to a large number of learners; promote an

illusion of reality; gain and hold attention of the learners; focus attention on highlights of key points; save time by limiting the use of wordy explanations, create impact; and facilitate understanding of abstract concepts.

As regards the visuals – projected (slides, filmstrips, overhead transparencies and opaque projections), or non-projected (still pictures, and graphics) – Ibe- Bassey (1988) maintains that they can serve as effective communication device when they present more concrete referent to meaning than the spoken or written words. The focus of this study was on graphics.

Graphics are those resources which can be prepared on such materials as plain papers, cardboards and other such 2- dimensional surfaces (Ayodele, 2001). They include diagrams, charts, graphs, posters and cartoons (Ibe- Bassey, 1986).

Studies show that graphics facilitates students' performance in the sciences better than teaching by exposition (James - Inyang, 2005; Thomas, 2006). James - Inyang(2005), investigating the effects of charts on students' performances in Biology, observed that students taught using charts performed significantly better than those taught using expository method only, irrespective of gender or school location. Similarly, Thomas (2006), in a study titled: Comparative effects of iconic, analogue and symbolic instructional models on students' performance and retention in chemistry, observed that analogue models (pictorial) facilitate performance and retention in chemistry better than symbolic models (diagrams and equations). Other studies indicating positive influence of graphics on students' academic performance include Obioma (1991), Ezeliora(1999) and Awotua - Efebo(2003).

STATEMENT OF THE PROBLEM

Unfortunately, studies still show that our science classroom interactions are dominated by teacher demonstration and expository methods of teaching without any recourse to effective use of graphic materials despite their instructional values(Njoku,2004). Besides, none of the studies reviewed attempted to compare the effects of the different types of graphics in students' performance in chemistry. What difference would exist in students' performance when taught with charts, diagrams, a combination of charts and diagrams; and without charts or diagrams? How would these instructional materials interact with gender?

PURPOSE OF THE STUDY

This study aimed at examining the effects of charts and diagrams on students' performance in chemistry. The objectives were;

1. To determine the effects of charts and diagrams on students' performance in chemistry.
2. To examine the interaction effects between the graphic materials and gender considering students' performance in chemistry.

RESEARCH HYPOTHESES

The following null hypotheses were formulated and tested:

1. There is no significant difference among the mean scores of students in chemistry when taught using charts, diagrams, a combination of charts and diagrams and without charts and diagrams.

2. To examine the interaction effect between treatment and gender, given students' performance in chemistry.

SIGNIFICANCE OF THE STUDY

It is expected that, apart from adding to the literature on the instructional values of graphics, the outcome of this study will, help teachers in proper selection and utilization of graphic materials for instructions in chemistry.

DEFINITION OF TERMS

In the context of this study, the underlisted terms are defined as indicated:
 Graphics: 2- dimensional instructional materials such as charts, diagrams, graphs, posters and cartoons.
 Charts: Graphics showing relationship between key facts and ideas (e.g. organization, classification, tabular, time- line, flow, flip, wall and pocket charts).
 Diagrams: Sketches or drawing used in representing persons, places, things and concepts.

THE RESEARCH METHOD

The Design

The non-randomized- pretest- posttest – control group design was used since the students were used in their class setting.

AREA OF STUDY

The study was conducted in Uyo Local Government Area of Akwa Ibom State. Uyo is the capital city of the state. It is bounded to the north by Itu, Ibiono, Ikono and Uruan Local Government Areas; to the east by Uruan Local Government Area; to the west by Abak; and to the south by Ibesikpo- Asutan, Nsit Ibom, Etinan and Mkpato Enin Local Government Areas.

Currently, the city hosts 14 coeducation secondary schools, and the University of Uyo, Uyo , as well as the State Government's Secretariat. The choice of Uyo as the study area was based on the assumption that as the seat of the state government and university town, the schools here are more favoured in terms of learning facilities and staffing.

POPULATION OF THE STUDY

The population comprised all senior secondary two (SS 2) chemistry students in the co-educational secondary schools in the study area during the 2006/2007 school session. The population size was 1,200(Source: The schools' enrolment in chemistry).

Sample Sampling Technique

The sample consisted of 158 SS 2 chemistry students in four intact classes, one each from four randomly selected co-educational secondary schools in the study area. Simple random sampling technique (balloting) was used in sampling.

INSTRUMENTATION

A researcher - developed instrument, Chemistry Achievement Test (CAT), with 20 multiple-choice items was used in collecting data for the study. Each item had five options with only one being correct. The items were based on the concept of Electrochemistry. A test-blue print was used to ensure even distribution of the items and validation of the instrument.

A draft of the instrument, which contained 40 items, was submitted to four independent assessors who are professional graduate chemistry teachers with not less than eight years teaching experience, for face and content validation. The assessors were, specifically, requested to check for the appropriateness of the items and content coverage. Based on their inputs, the number of items was reduced to 28. Following face validation, the 28- item instrument was trial tested on a sample of 40 SS2 students from schools not used for the study to determine their difficulty and discrimination indices. From this indicates, items with difficulty indices below 25% and above 70% were dropped for either being too difficult or too simple; and those with discrimination indices below 0.25 and 0.70 were also dropped for lacking potentiality to discriminate between the fast and slow learners. This reduced the number of items to 20 in the final form of the instrument.

RELIABILITY OF THE INSTRUMENT

The reliability of the instrument was determined using split- half approach, and Pearson Product Moment Correlation (PPMC) statistics was used in calculating the reliability index. The trial test scores for the selected items were used in calculation. The result showed that CAT had a reliability coefficient of 0.76. Hence, the instrument was considered reliable and stable.

SCORING

Each correct answer was scored 5 marks and incorrect answer, zero. This gave a maximum of 100 marks and a minimum of zero.

RESEARCH PROCEDURE

Following validation of the instrument, the researchers obtained permission from the authorities of the sampled schools to use the schools for the study, and to solicit for cooperation from the subject teachers as research assistants. To qualify, the researchers took a week to train these teachers on how to conduct the study using validated lesson packages developed by the researchers for the respective groups. At the end, they were subjected to mock teaching session during which they were assessed and helped where necessary. Thereafter, they were allowed to teach their respective groups under the supervision of the researchers using the validated lesson package after pretest administration.

The four sampled schools were randomly assigned to four treatment groups. Group 1, was taught using charts only; Group 2, was taught using diagrams alone; Group 3, was taught using a combination of charts and diagrams and Group 4, was taught without charts or diagrams. Classroom interaction lasted for 3 weeks after which a reshuffled version of CAT used in pretesting, was re-administered as posttest.

METHOD OF DATA ANALYSIS

The data obtained from pretest and posttest was analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA) statistics. All the hypotheses were tested at $P < .05$ level of significance.

Table 1: Mean and standard deviation scores of students' pretest and posttest performance classified by treatment and gender.

Treatment Groups	Gender	Sample		Pretest		Posttest		Mean Gain	
		size (N)	X	SD	X	SD	X		SD
Charts	Male		19		28.42	6.68	53.68	7.04	25.26
	Female		18		34.72	9.31	54.44	7.05	19.72
	Total		37		31.49	8.57	54.05	6.96	22.56
Diagrams	Male		27		30.93	8.99	56.11	6.98	25.18
	Female		19		28.42	7.83	55.26	5.39	26.84
	Total		46		29.89	8.53	55.76	6.32	25.87
Charts & Diagrams	Male		25		31.40	8.48	60.00	4.33	28.60
	Female		19		32.63	5.86	57.63	4.52	25.00
	Total		44		31.93	7.41	58.98	4.52	27.05
Without Charts & Diagrams	Male		13		32.69	8.32	50.00	8.17	17.31
	Female		18		29.72	8.13	47.22	5.21	17.50
	Total		31		30.97	8.21	48.39	6.63	17.62
Total	Male		84		30.77	8.23	55.77	7.26	25.00
	Female		74		31.35	8.08	53.72	6.73	22.37
	Total		158		31.04	8.14	54.81	7.07	23.77

Mean gain Score = posttest – pretest mean difference; X = mean; SD = standard deviation

In Table 1, the mean gain scores of students taught using charts, diagrams, a combination of charts and diagrams and without charts or diagrams are 22.56; 25.87; 27.05 and 17.62, respectively. These results indicate that students taught using a combination of charts and diagrams gained most from the instructions given, followed by those taught using diagrams, charts and without charts or diagrams in decreasing order.

On performance by gender, the results indicate an inconsistent trend. While the males in charts and charts and diagrams groups performed better than their female counterparts, the females in diagrams and without charts or diagrams groups performed better than their male counterparts. However, with the grand mean gains of 25.00 and 22.37 for males and females respectively, the results indicate that generally the males gained more than their female counterparts.

Hypothesis 1: There is no significant difference among the mean scores of students in chemistry when taught using charts, diagrams, a combination of charts and diagrams

and without charts and diagrams. This null hypothesis was tested using the ANCOVA results in Table 2.

Table 2: Summary of analysis of Covariance (ANCOVA) of students' posttest performance classified by Treatment and gender with pretest as covariance

Source of variance	Sum of Squares	df	Mean Square	F.cal	Calc.Level of Significance	Decision at P<.05 Level of Significance
Corrected Model	2265.25	8	283.16	7.56	.00	Significant
Pretest (covariate)	27.37	1	27.37	.73	.39	Not Significant
Treatment(Graph ics)	1900.61	3	633.54	16.92	.00	Significant
Gender	65.42	1	67.42	1.80	.18	Not Significant
Treatment x Gender	57.46	3	19.16	.51	.68	Not Significant
Error	5579.06	149	37.44	-	-	-
Corrected Total	7844.30	157	-	-	-	-

R- squared = .289; Adjusted R squared = .251

In Table 2, the calculated F- value for the effect of graphics as students' performance is 16.92, and its corresponding level of significance is .00. This calculated level of significance (.00) is less than the 0.05 level on which decision is based. This implies that the effect of graphic on students' performance is statistically significant. That is there is a significant difference among the mean scores of students taught with charts, diagrams, charts and diagrams and without charts and diagrams. With this observation, the null hypothesis 1 was rejected. In order to determine the direction of significance, a post- hoc analysis was done and the results are summarized in Table 3.

Table 3: Scheffe post-hoc test of students' posttest performance classified by treatment groups.

(I) Treatment Groups (J)	Treatment Groups	Mean Difference	Calc. Level of Significanc e	Decision at P<.05 level
Charts	Diagrams	-1.71	.66	Not Significant
	Charts and Diagrams	4.92*	.01	Significant
	Without charts or diagrams	5.67*	.00	Significant
Diagrams	Charts	1.71 -3.22	.66	Not Significant
	Charts and Diagrams	7.37*	.11	Not Significant
	Without Charts or diagrams		.00	Significant
Charts & Diagrams	Charts Diagrams Without	4.92* 3.22	.01.11.00	Significant
	Charts or Diagrams	10.59*		Not Significant
Without Charts or Diagrams	Charts Diagrams With	-5.67*	.00.00.00	Significant
	Charts and Diagrams	7.37*		Significant
		-10.59*		Significant

In Table 3, the mean differences are: charts and diagrams – without charts or diagrams = 10.59; diagrams – without charts or diagrams = 7.37; charts – without charts or diagrams = 5.67; charts and diagrams – charts = 4.92; charts and diagrams – diagrams = 3.22; and diagrams – charts = 1.71. These results indicate that the facilitative effect of the graphics is in the order: charts and diagrams > diagrams > charts > without charts or diagram. That is, using a combination of charts and diagrams produces the best effect on students' performance followed by diagrams, charts and without charts or diagrams in decreasing order.

Hypothesis 2: To examine the interaction effect between treatment and gender given students' performance in chemistry. This hypothesis was tested using the result in Table 2.

In Table 2, the calculated F- value, F-cal, for the treatment – gender interaction is 0.51, while its corresponding calculated level of significance is 0.68. A comparison with the probability level of 0.05 alpha, in which the decision is based, shows that the calculated significance level(.68) is greater than 0.05 level, indicating that the interaction effect is not statistically significant. That is, the same at all levels of gender. With this observation, null hypothesis two was retained.

Discussion

The focus of study was on the relative effectiveness of charts, diagrams, a combination of charts and diagrams, and teaching without charts or diagrams in facilitating students' performance in chemistry. The observations made indicate that the use of a combination of charts and diagrams has the highest facilitative effect on students' performance followed by diagrams, charts and without charts or diagrams in decreasing order. This implies that the use of a combination of charts and diagrams in communicating chemistry concepts to learners could enhance students' performance, much better than using charts or diagrams alone, or teaching without these graphics. It was also observed that all the graphic materials investigated were gender friendly.

The observed superior effect of a combination of charts and diagrams compared to other graphic modes could be attributed to combined instructional values of charts and diagrams. While diagrams give sketches or drawing of the observable or unobservable objects or phenomena with only instructional details, the charts give the relationship between the key facts and ideas about the concepts or phenomena. The observations agree with those of Ezeliora(1999), Awotua- Efebo(2003), James-Inyang (2005) and Thomas(2006); and underscore the fact that graphic materials if effectively employed in the teaching learning situation can greatly enhance students' performance(Awotua- Efebo, 2003). Based on these findings, it is recommended that chemistry teachers should use a combination of charts and diagrams in teaching chemistry concepts.

Conclusion

Consequent upon the observations made, it is hereby concluded that the use of a combination of charts and diagrams facilitate learning much better than using charts or diagrams alone, or teaching without charts or diagrams.

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