EFFECT OF GRAPHIC ORGANIZER IN INTEGRATION CONCEPT AMONG SECONDARY SCHOOL MATHEMATICS STUDENTS IN MKPAT ENIN, AKWA IBOM STATE.

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ABSTRACT

The study investigated the use of graphic organizer in teaching integration and students' achievement in senior secondary school mathematics in Mkpat Enin Local Government Area. Three research questions and corresponding research hypotheses guided the study.Quasi-experimental research design, specifically; pre-test post-test non-randomized control group design was used. The population of the study was 1935 senior secondary three (SS3) students during the 2023/2024 academic session in Mkpat Enin, Akwa Ibom State, sample size of 129(64 Male and 65 Female) students were randomly selected fromthe target population. The instrument used for collection of data was Mathematics Achievement Test (MAT) on integration with a reliability coefficient of 0.72 using Test retest method. Hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result of the study showed a significant difference among the mean achievement scores of students taught integration using graphic organizer and those exposed to lecture strategy. Findings of the study revealed that students taught using graphic organizer achieved significantly higher in their mean scores compared with the lecture strategy. Based on the findings of the study, it was concluded that graphic organizer is a good strategy for teaching integration. It is therefore recommended among others that mathematics teachers should adopt the use of graphic organizer in teaching integration.

Keywords: Graphic Organizer, Achievement and Gender.

INTRODUCTION

Mathematics spreads across nature. It plays vital role in accelerating the social, economic and technological growth of any nation. Today's world thrives on science and technology that demands mathematical knowledge. Mathematical literacy is an indispensable attribute that individuals should possess, in a bid to living more effective lives as constructive, concerned and reflective citizens. A paradigm shift is needed for moving mathematics from the world of mystery to part of daily life. This will go a long way in making the technological advancement of

the nation and world at large start from the home to the learner. To this end, it is necessary to prepare today's learners with a strong foundation in mathematics (Crowe, 2022).

Many topics in schools' mathematics curriculum are seen as difficult to learn by students. Integration is one of such topics. This is evident in students' results both in internal and external examinations. This difficulty in the learning of integration necessitates deep insights into mathematics learning to demystify the subject. This can only be achieved through better teaching of mathematics topics including integration. Integration as a topic comes under introductory calculus in the curriculum. Calculus is a branch of mathematics that deals with the rate of change of one variable with another. Calculus is broadly classified into two broad areas: differential and integral calculus. The derivative is a measure of the rate of change of quantity with respect to another, whereas integral is the measure of the area under a curve. The derivative explains the function at a specific point while the integral accumulates the discrete values of a function over a range of values (Byju's, 2021).

Integration is an essential concept which is the inverse process of differentiation. Integration simply means collecting things, adding them and forming something solid. While differentiation means breaking up something into tiny quantities (Sur, 2022). Integration can be classified into two different categories, namely: Definite integral and indefinite integral (Maths Is Fun, 2024).

Definite integral is an integral that contains the upper and lower limits, that is, the start and the end value. The value of $\varkappa$ is restricted to lie on a real line, and a definite integral is also called Rieman integral when it is bounded to lie on the real line. A definite integral is represented as: $\int_b^a f(x)dx$. On the other hand, Indefinite integrals are not defined using the upper and lower limits. The indefinite integrals represent the family of the given function whose derivatives are f, and it returns a function of the independent variable. Here, a constant C is always attached to the answer (CueMath, 2023).

Calculating areas and volumes dated from Ancient Greek mathematics, the principles of integration were formulated independently by Isaac Newton and Gottfried Wilhem Leibniz in the late 17^{th} century, who thought of the area under a curve as an infinite sum of rectangles of infinitesimal width. From (www.profdave explains), the work of Isaac Newton Wilhemm Liebnitz was explained. Here finding area of regular shapes like square, rectangles and trapezium was carried out. But the question remained, to find area of irregular shapes. Since mathematics is progressive, to find area of irregular shape, a case study of area under a curve will be used. From the works of Newton and Liebniz, the irregular area under the curve will be divided into smaller rectangles. The area of the smaller rectangles, with constant width and varied heights will be found separately. Then summed up to find area of the bigger rectangle. As shown below:

It will be observed that the smaller the width of the rectangles, the closer the answer of the area is, to accuracy. Hence, instead of spending time to divide the rectangles to infinite sizes, integration can be used to get the exact answer at once (as shown below). That's how the idea of integration started and grew to complex stages.

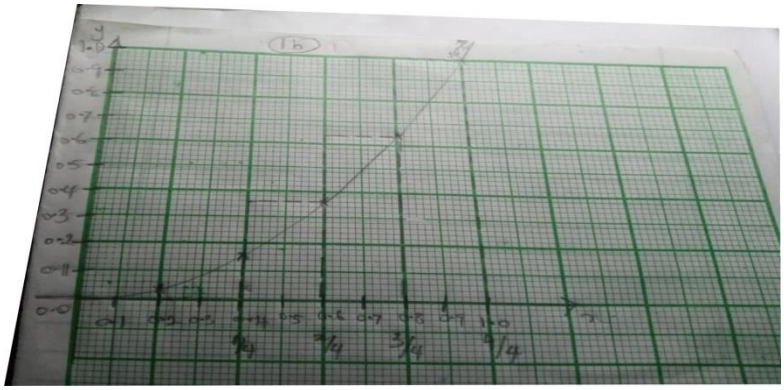

Figure 2.4: Area of a curve

To find the area under the curve from the graphs above the area is between O and I on both X and Y axis. First, using the practical approach to find the area which L X b or b x h. we will let x = breadth or with and y= height. So b x h = X x y to find the area of the rectangle, we divide then into smaller rectangle (according to newton and Liebniz) and find the area of the smaller rectangles, then latter add then up (Z or ∫) to find the area of the big rectangle.

First, we divide them into 4 rectangles (see 1st graph above), their areas (from graph) are

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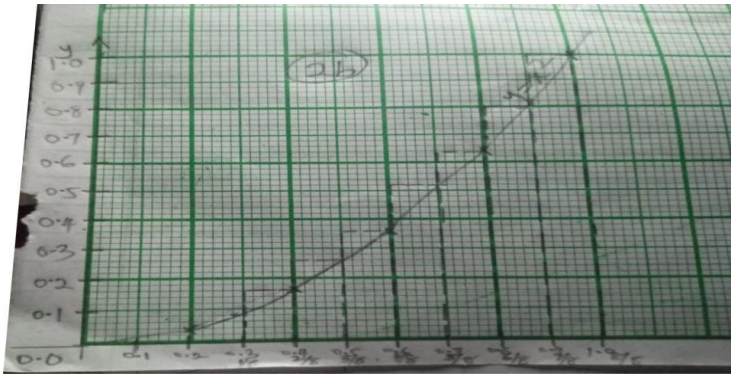
S/N	X	Y	XY
1	0.25	0.625	0.15625
2	0.25	0.25	0.0625
3	0.25	0.5625	0.140625
4	0.25	1	0.25
			0.609375

Note: the width remains, constant, only height changes

Note: the width remains, constant, only height changes

2nd graph:

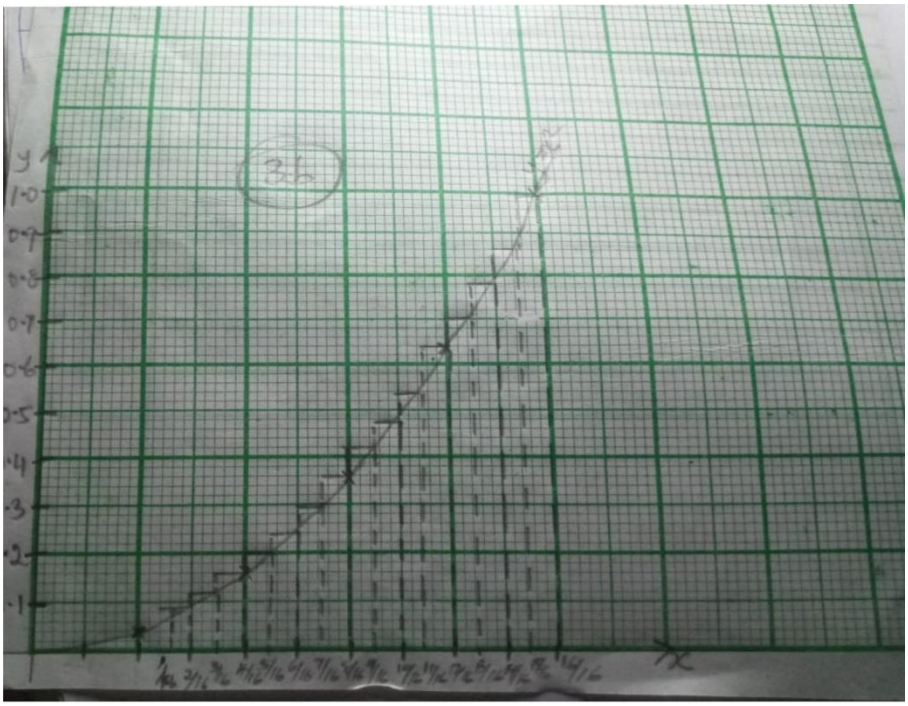


Recall: L_z = x , height y and also recall that the breath (x) remains the same (constant)only the height Varies (y).

Now 8 rectangles

s/n	X	Y	XY
1	$\frac{1}{8}$ = 0.125	0.8	0.1
2	$\frac{1}{8}$= 0.125	0.16	0.02
3	$\frac{1}{8}$ = 0.125	0.26	0.0325
4	$\frac{1}{8}$ = 0.125	0.36	0.045
5	0.125	0.5	0.0625
6	0.125	0.64	0.08
7	0.125	0.8	0.1
8	0.125	1.0	0.125
			0.44

3rd graph



S/N	X	Y	XY
1	0.0625	0.05	0.003125
2	0.0625	0.08	0.005
3	0.0625	0.1	0.00625
4	0.0625	0.16	0.01
5	0.0625	0.18	0.01125
6	0.0625	0.24	0.015
7	0.0625	0.28	0.0175
8	0.0625	0.38	0.02375
9	0.0625	0.41	0.025625
10	0.0625	0.48	0.3
11	0.0625	0.56	0.035
12	0.0625	0.64	0.04
13	0.0625	0.7	0.04375
14	0.0625	0.8	0.05
15	0.0625	0.88	0.055
16	0.0625	1.0	0.625
			0.43375

Subsequently areas of:

100 rectangles = 0.33835

1000 rectangles = 0.33383

From observation, the answer is getting closer to accuracy

But, we can use integration to find infinitely smaller number of rectangle to arrive at accuracy thus:

The function is $y = x^2$

$\int x^2 dx$. Integrating between the intervals of 0 to 1 gives $[\frac{x^3}{3}]_1^0 [\frac{1^3}{3} - \frac{0}{3}] = 0.333$

It is observed that the smaller the width of the rectangles, the closer the answer of the area is, to accuracy. Hence, it was concluded that instead of spending time to divide the rectangles to infinite sizes, integration can be used to get the exact answer at once. Adequate strategies of teaching various concepts in the classroom determines students' academic achievement.

Academic achievement is the amount of academic content a student learns in a specific period. This can be in any way a student has achieved his or her short- term or long-term academic goals within an academic setting (Barowski and Carter, 2021). Academic achievement must be measurable, which is the reason distinct goals are used as a defining characteristic. Drew (2023) also explained that academic achievement is the level of success or achievement attained by an individual in an academic setting. It encompasses a broad range of factors including grades, test scores, research outcomes and overall academic performance.

Another variable considered here is gender. Andrews, Cook, Nielson and Xiao (2020) stated that gender plays a role in students' experiences at school, but these experiences are quite different from students who vary from the norm in terms of gender identity and expression. World Health Organization (2024) explained that the behavioural pattern of women, men, girls and boys which are socially constructed, points to the meaning of gender. The socially constructed roles are the norms and behaviours associated with being either a woman, man, boy or girl. Gender is hierarchical and produces inequalities that intersect with other social and economic inequalities.

The various levels of mathematics achievement can be influenced by strategies adopted by a teacher. The strategy considered in this study are Graphic organizer and Lecture strategies.

A teaching strategy can be described as a set of methods that are used to help an individual learn new material. Teaching strategies according to Sinha (2024) are a collection of different methods that are all in use by the teacher to teach the subject material and these may vary from lesson to lesson. Sinha further said that teaching strategies can also be defined as "a method or set of methods used by a teacher to teach the subject matter" while describing method of teaching as a procedure, a process or a way something is done or implemented. With the aforementioned reasons, graphic organizer is regarded as a strategy of teaching.

Graphic organizer is a great way to display information visually. It is a way of presenting pieces of information visually to aid students' comprehension. Graphic organizers have such benefits as: helping students to classify ideas and examine relationships, improves students' reading comprehension by making information digestible as well as helping learners understand how processes work by systematically showing cause and effect (Dean, 2024, Jill Stake, 2024 and Inspiration, 2024).

According to Ham (2023) and Kelum, Dehideniya and Sakunthala (2021), mathematics teaching has mainly been through the use of lecture strategy. This strategy has a critical role in

introducing the students to higher mathematics and shaping students' interest and curiosity to learning mathematics. It should be borne in mind that the process of interpreting the world of knowledge into the mind of the learners, through whatever means is simply known as method of teaching. Lecture method, also known as the transmissive method, is based on vertical learning, whereby the teacher has all the knowledge and pours them into the learners.

Empirical studies by Oginni (2021) on the effects of graphic organizer and animation on students learning outcomes in Mathematics revealed that there is significant difference in the learning outcomes of students taught using graphic organizer, animation and conventional strategies. Fabros and Ibanez (2023) found out that when learners are exposed to graphic organizer, their scores and level of conceptual understanding are improved. Owolabi and Adaramati (2015) investigated the effects of graphic organizer and gender on students' academic achievement in algebraic word problem. The finding revealed that the experimental groups performed better than the control group, the treatment appeared to be more effective among male students than their female counterparts, the main effect of treatment was significant and the main effect of gender as well as the interaction effects of treatment and gender were not statistically significant.

STATEMENT OF THE RESEARCH PROBLEM

Before now, integration as a topic was in Further mathematics curriculum. Other students did not have the opportunity to learn integration. When students have admission into tertiary institutions, they are faced with MTH111(General Mathematics 1) and MTH 121(General Mathematics 11). Integration was then moved to mathematics curriculum to prepare candidates for their tertiary education. Even at this, many students do not still get to learn this integration. This is because of dearth of qualified and competent mathematics teachers in many schools. Currently, students of mathematics are performing poorly even in other science-based courses in senior secondary schools. The cause of the poor results is easily traced to the students' poor foundation in mathematics from the primary and carried over to the secondary school (Petterson and Xenophontos, 2022). Perhaps if prospective tertiary level candidates had studied Mathematics adequately prior to their admission where topics on introductory calculus such as differentiation and integration are properly taught, new intakes into the tertiary level would have had less difficulty in their required mathematics courses. The move to address some of the difficult topics in secondary school Mathematics is even imperative at this time of paradigm shift from Basic Minimum Academic Standard (BMAS) to Core Curriculum Minimum Academic Standard (CCMAS). Will students at the secondary school level achieve better in integration when taught using Graphic organizer or lecture strategy?

OBJECTIVES OF THE STUDY

The objectives of this Study were to:

- Determine the achievement of students taught integration using graphic organiser and those exposed to lecture strategy.
- Determine the mean achievement scores of male and female students taught integration using graphic organiser and lecture strategy.
- Determine the variation in students' achievement attributed to strategy and gender.

RESEARCH QUESTIONS

The following research questions guided the study:

- What is the mean achievement scores of students taught integration using Graphic Organizer and those exposed to lecture strategy?
- What is the mean achievement scores of male and female students taught integration using Graphic organizer strategy
- What variation in students' achievement is attributed to strategy and gender ?

RESEARCH HYPOTHESES

The following hypotheses were tested at .05 level of significance:

- $H_{O1\ There}$ is no significant difference in the mean achievement scores of students taught integration using graphic organizer and those exposed to lecture strategies;
- H_{O2} There is no significant difference in the mean achievement scores of male and female students taught integration using Graphic organizer strategy;
- H_{03} There is no significant interaction effect of strategies and gender on mean achievement scores of students taught integration using graphic organizer strategy.

METHODOLOGY

Quasi-experimental research design, specifically, pre-test post-test non-randomized control group design was uesd. The population of the study was 1935 senior secondary three (SS3) students during the 2023/2024 academic session in Mkpat Enin, Akwa Ibom State, sample size of 129 (64 Male and 65 Female) students were randomly selected from the target population. Purposive sampling technique was used in selecting the two schools with the following criteria:

- The school that has qualified mathematics Teachers with at least three years of teaching experience
- School that has presented candidates in the past five years for Senior Secondary School Certificate Examination (SSCE).

A simple random sampling technique to select one intact class for Experimental group and another intact class for the control group. The instrument used in this study was Mathematics Achievement Test (MAT). There were two instructional guides, namely: Instructional Guide on Graphic Organizer (IGGOS) and Instructional Guide on Lecture Strategy (IGLS) respectively. The Mathematics Achievement Test (MAT) had a reliability of 0.72 using Test retest method. All the instruments were duly validated by experts review.

The first week was used for the training of the participating teachers in each of the schools by the researchers on the use of IGGOS and IGLS. The second week was used for the administration of pre-test by the Teachers and researchers on MAT. The next three weeks (weeks 3-5) were used for the administration of treatment to experimental groups 1, Graphic Organizer Strategy group (GOS), and the control group, Lecture Strategy group (LS). Week five was used for administration of posttest. After two weeks interval (weeks 6 and 7), week 8 was used for administration of retention test by the teachers and researchers.

PRESENTATION OF RESULTS

The Results of this study is organized under research questions and hypothesis as well as the descriptive of students' scores.

Table 1:
The Descriptive of Students' Mean Scores and Standard Deviations by Pretest and Post test tests

Variables		Pretest	Posttest
Graphic Organizer	Mean	7.61	36.41
	N	49	49
	Std. Deviation	2.129	2.327
Lecture	Mean	7.16	32.34
	N	38	38
	Std. Deviation	1.952	2.221
Gender			
Male	Mean	7.42	33.97
	N	64	64
	Std. Deviation	2.022	2.725
Female	Mean	7.03	38.58
	N	65	65
	Std. Deviation	1.741	3.010

On Table 1, Descriptive of students' mean scores by Pretest and Posttest are as indicated. There are two independent variables for which scores are indicated on the table. These are strategies at two levels namely: Graphic Organizer and Lecture strategies. The others are gender at two levels of male and female. Students' scores are as indicated on the table for each level of independent variable.

Research Questions

The research questions were answered using mean and standard deviations

Research Question One

What is the mean achievement scores of students taught integration using Graphic Organizer and those exposed to lecture strategies?

Table 2:
Mean and Standard Deviation of Students' Scores by Graphic Organizer, and Lecture.

Strategy	N	$\bar{x}$	SD
Graphic organizer	49	36.151[a]	0.270
Lecture	38	32.786[a]	0.317

a. Covariates appearing in the model are evaluated at pretest = 7.22

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments)

The scores shown on table 4.2 are adjusted by using pretest scores as covariates to the posttest scores.

As shown in Table 2, the adjusted mean scores of 49 students who were taught Integration using Graphic Organizer is 36.151 with a corresponding standard deviation of 0.270. Similarly, the 38 students taught Integral Calculus using Lecture method had a mean score of 32.786 with a corresponding standard deviation of 0.317. It can be observed from the table that graphic organizer group had the higher mean score.

Research Question Two

What is the mean achievement scores of male and female students taught integration using Graphic organizer strategy?

Table 3: Mean and Standard Deviation of Students' Score by Gender

Gender	N	Mean	SD
Male	64	33.775[a]	0.290
Female	65	34.723 [a]	0.250

a. Covariates appearing in the model are evaluated at the following values: PRETEST= 7.22.

As shown in Table 4.3, the adjusted mean scores of 64 the male students who were taught integration is 33.775 with a corresponding standard deviation of 0.290, while the adjusted mean score of 65 female students taught integral calculus is 34.723 with a corresponding standard deviation odd 0.250. The difference between the two mean scores is 0.948.

Research Question Three

What variation in students' achievement is attributed to strategy and gender ?

Table 6:

Analysis of Covariance of Students' Score by strategy and Gender

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected	692.199[a]	18	38.456	11.503	.000
Intercept	5738.226	1	5738.226	1716.376	.000
PRETEST	83.708	1	83.708	24.038	.000
STRATEGY	230.647	2	115.324	34.495	.000
GENDER	20.110	1	20.110	6.015	.016
STRATEGY*GENDER	13.917	2	6.959	2.081	.130
Error	367.754	110	3.343		
Total	152642.000	129			
Corrected Total	1059.953	128			

a.R Square = .653 (Adjusted R Squared =.596).

All data were obtained using pretest scores as covariates with post test

On Table 6, the computed F- value for strategies is 34.495 with a corresponding P- value of 0.000. The P- value is less than the α –level of 0.05. Hence, strategy is significant. The pairs of levels between which differences are significant are however determined using a post hoc analysis as in Table 7

Table 7
Posthoc Test Comparison Among Strategies

(I)Strategy	(J)Strategies	Mean Difference (I-J)	Std.error	sig[b]	p≤.05
Graphic organizer	Lecture	3.308*	0.376	0.000	

The mean difference is significant at the0.05 level.

The purpose of a post hoc test is to determine the pair of variables between which a significance is established. Table 7 depicts that two are significant differences: between the mean scores of the group of graphic organizer and lecture group.

DISCUSSION OF FINDINGS

The findings of the study could be attributed to the fact that graphic organizer helps students to classify ideas and examine relationships, improves students' comprehension by making information digestible as well as help students to understand how process work by systematically showcasing cause and effect. It helps students to organize new information, brainstorm ideas, make meaningful connections between the main idea and other information, improve student understanding, achievement and increase knowledge retention and give students an easy and flexible way to map out any concept or idea thereby improving academic achievement of students (Torrefranca, Estacio and Reyes, 2022). The findings of this study corroborate Fabros and Ibanez (2023) who found out that graphic organizer is an effective approach in improving the conceptual understanding and thus mathematics teachers ought to integrate it in their teaching. Also, graphic organizer improves the level of conceptual understanding as well as improve scores of students. Also, students exposed to graphic organizer achieved better than their counterparts who were not exposed to graphic organizer.

Moreover, findings from the results on the difference in the mean achievement scores of male and female students taught the concept of integral calculus using graphic organizer and lecture method as strategies indicated a non-significant difference. The findings confirm the statement of Ajai and Imoko (2015) and Pina, Martella, Moscoso, Saracostti and Cortes (2021), who opined that male and female students are capable of competing and collaborating in mathematics with high achievement levels and that there are no longer distinguishing differences in the cognitive, affective and psychomotor skill achievements of students in respect of gender and that girls are being encouraged and sensitized into developing positive attitudes towards science, which subsequently result in high academic achievement and retention. The findings of the study are also in line with that of Oribhabor (2022), who found out that male students had slightly better performance compared to the female students but it was not significant.

CONCLUSION

The result of this study highlighted the effects of Graphic organizer and Lecture strategy in fostering students' academic achievement in Mathematics when taught the concept of integral calculus. Graphic organizer helped the students to overcome the difficulties inherent in learning the concept of integral calculus. Based on the findings of the study, it was concluded that graphic organizer is an important strategy in enhancing students' academic achievement of the concept of integral calculus for both male and female students. There existed no significant difference in the achievement scores of male and female students taught the concept of integral calculus using Graphic Organizer and lecture method as strategies.

RECOMMENDATIONS

Based on the findings of the study, it was recommended that:

- Mathematics teachers and educators should be encouraged to adopt Graphic Organizer as strategy.
- Graphic organizer as strategy which is purposive and efficient should be used in teaching integral calculus so that the students can obtain the full benefits of the lesson.
- Education stakeholders should organize conferences, seminars, and workshops for teachers to acquaint them with the knowledge on the use of graphic organizer as Mathematics strategy to improve the process and product of teaching.
- Textbooks authors should adopt graphic organizer strategy in their books to support students' organization of concepts and learning.
- Strengthening the use of graphic organizer through in-service course could help science teachers to adopt proper use of good strategies.

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