FROM CHAO TO CLARITY: TRANSFORMING LEARNING WITH GRAPHIC ORGANISERS FOR IMPROVED SECONDARY SCHOOL STUDENTS ACADEMIC PERFORMANCE IN ICT

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Abstract: *A graphic organiser is one of the teaching methods that can assist learners to organize information, structuring the information and relating the concept to another. Secondary school students perceived computer networks as one of the difficult concepts in computer studies. This study examines the potency of graphic organisers in learning computer networks in the newly implemented ICT curriculum in Nigeria. This study employed a quantitative research approach. The data collected was analysed with ANCOVA with pre-test scores as the Covariate. The results from the study reveal that students in the experimental*

group performed better than their counterparts in the control group due to the intervention they had. Thus the results show that there is a significant difference in the performance of students taught computer networks using the two methods- graphic organisers and lecture method irrespective of their gender. This study is unique because it relies on the testing of visual and graphical representations of contents in reducing the hitches in the study of computer networks which justifies the adoption of the graphic organisers in learning ICT.

Keywords: *Graphic Organiser, Information, Communication and Technology, Academic performance, Computer Networks*

Introduction

To raise generations that can think critically, make the right decisions at the appropriate time and find solutions to difficult situations in life requires equipping them with the appropriate and significant teaching-learning pedagogical skills rather than exposing them to ready-made materials for memorization (Tureniyazova, 2019). To accomplish this pedagogical skill, effective teaching and learning strategies require technologies that must instil in the learners' ability to analyse the educational information that is received to solve specific problems. According to See (1994), technology involves the act of generating knowledge that assists in solving problems. It helps in changing the way people access, gathers, analyse, present and simulate information (Ghavifekr, et al., 2012)

Technology in this 21st century has become important to all fields most especially in education. It is now seen as the best knowledge transfer medium in most of countries in the world. (Ghavifekr & Rosdy 2015). Using technology in education these days has gone through a lot of innovations which has changed the way people live, reason and do things now (Jiang & Grabe 2007). As a result of this, all schools and institutions need to prepare students through the integration of technology into their curriculum.

The integration of Information, Communication and Technology (ICT) in the secondary school curriculum is to make teaching and learning more technology-based which will allow students to learn through the utilisation of technology within and outside the school environment. Since students now have access and they are familiar with technology, they will learn faster and easier within the technology-based environment (Ghavifekr & Rosdy 2015). ICT being a subset of

technology is one of the subjects newly introduced to the Nigeria school curriculum in the last few years. This is justified by global trends and growing awareness with the intent to positively influence the teaching-learning process and promotes national development. (Dias & Atkinson, 2001).

Studies have shown that ICT plays an important role in student's academic performance as it could be used for effective instructional delivery in schools (Adesina et.al 2014; Ghavifekr & Rosdy 2015; Valverde-Berrocoso, et al., 2022). ICT has the capacity of bringing real-life situations into the classroom setting which was cannot done in a traditional class setting. This is because it provides the learners with the opportunities to interact and collaborate (Baytak, et al., 2011). In Nigeria, it is generally believed that basic ICT skills are essential for students to access information that is needed to write external examinations through online platforms (Agbo, 2015). These imply that, without having basic ICT knowledge students may not gain admission into higher institutions (Basri et al. 2018).

The application of ICT knowledge and skills has become a critical part of the teaching-learning process. ICT skills can assist in facilitating student-centred learning (Drent, 2005). However, despite its benefits to society generally and considering its advantages to teaching and learning in this 21st century, secondary school students still perceived some concepts difficult in ICT (Gbeleyi et.al 2022). A Plethora of studies confirmed that students' poor performance in ICT can be attributed to a lack of ICT facilities, limited financial resources, students' attitudes towards learning and most importantly ineffective teaching methods (Okorie & Agah 2014, Wabwoba 2019, and Atandi, et al.; 2019). Premised on this fact, Owolabi and Okebukola (2009) agreed that the methods of teaching employed play significant roles in students' learning ability.

Students' academic performance in this context is described as the systematic improvement of the student's current state of knowledge and the level to which such knowledge can reflect the skills acquired in the internal and external examinations. Student's academic performance is also the development of their personality and academic growth from lower to higher levels of study. To improve the learner's academic performance, traditional methods which are teacher-centred with no learners activities should be discouraged (Noor et.al. 2020). Onowugbeda, et al, (2022), opined that the traditional method deprives students of the opportunity to engage in hands-on activities using technological tools and relevant instructional resources which would have promoted students' academic performance in the subject and improved their attitude to learning.

Despite the importance of ICT and other ICT-related subjects to bring meaningful learning and advancement in technology which can shift the paradigm from a teacher-mediated method to a student-mediated method (Odekeye et al. 2023). It's still appalling to note that students' academic performance in ICT at all levels remains very poor (Okeji et al., 2020). This informed that alternative pathways could be explored to ease the problem of poor academic performance in ICT through graphic organisers.

Graphic organisers are communication tools for visual displays used by teachers to give information in a way that facilitates the understanding and learning of the information. (Meyen, 1996). According to Woolley (2010), graphic organisers give significant structure to information that cannot be disseminated in the traditional written form but through visual representation. Hall and Strangman, (2002) believe that graphic organisers are visual representation that show connections among facts, figures terms and ideas within a learning task. The visual representation of textual information provided by graphic organisers makes it easier to assimilate the information. They allow learners to delve deeply into the core of the concepts, examine the concepts and understand the relationships to construct an algorithm to solve the problem. Learners can cultivate a creative imagination, form various associations, and come up with unique ideas with or without any assistance because graphic organisers are mapping techniques used to facilitate learning when limited time is given with a large amount of information to work with (Praveen & Premalatha, 2013).

The concept of the graphic organisers was also derived from Ausubel's assimilation theory of cognitive learning, as stated by Zaini et al., (2010). According to them, the information is structured in a hierarchical pattern by the mind, moving from the most relevant to the least relevant. The goal of the cognitive method of teaching and learning is to get an understanding of how information coming in is processed and organised in the memory.

According to Ausubel (1963), the use of graphic organisers has a significant impact on learning because it gives learners a meaningful framework within which they can integrate previously acquired knowledge with newly acquired information. Students are provided with a tool that allows them to arrange the content, identify crucial concepts, and concentrate on the most relevant information through the use of graphic organisers (Knight et al. 2001). Clark (2007) further posited that graphic organisers does not only allow learners sort information, but also assist them to understand difficult concepts, singly generate thoughts, and identify connections between ideas generated. In addition, graphic organisers give learners more control

over the text they are reading and help them better comprehend it (Farris 2001), Graphic organisers are instructional tools that facilitate learners to search for information and arrange those information and concepts to relate with new concepts. (Owolabi & Adaramati, 2015).
Studies have shown that teaching can be assisted effectively and efficiently with graphic organisers to improve students' academic performance (Robillos 2023; Sharma, 2012; Praveen & Premalatha, 2013; Kumar-Manoj & Rizwaan, 2013). Odewumi & Gambari, (2019) also confirmed in their study that graphic organisers had been effectively used to improve the academic performance of students in subjects like Mathematics (Mercer & Miller, 2003; Githua & Nyabwa (2008), Science subjects (Condidorio, 2010), Writing (Jasmine & Weiner 2007), Home Managements (Alshatti, et al., 2012), & Health Education (Kools et al., 2006). The use of graphic organisers also benefited students with learning disabilities. (Dexter & Hughes, 2011).

1. Why Computer Networking?

A survey study was conducted by Okebukola et al. (2020) as cited by Awah et al., (2022) to investigate concepts perceived as difficult in the new computer studies curriculum among secondary school students in Africa (Nigeria and Ghana). 1501 (male=734, female=767) computer studies students participated in the study. Nigeria and Ghana were selected because the two countries used the same computer studies syllabus for West Africa Senior School Certificate Examinations. The study revealed that computer networking was ranked one of the most difficult among the 19 concepts perceived as difficult by students. Therefore, the researcher's interest in this study is to find out how to use graphic organisers to ease the difficulties experienced by computer studies students in Nigeria in computer networks.

2. The study sought to provide answers to these questions:

i. Will there be any significant difference in the academic performance of students taught computer networks with graphic organisers and the lecture method?
ii. Will there be any significant difference in the academic performance of male and female students taught computer networks using graphic organisers and the lecture method?

2.1 In line with the purpose of the study, two hypotheses were generated to guide this study:

i. There is no statistically significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods.

ii. There is no statistically significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods based on gender.

Theoretical Framework

The theories and studies conducted by Ausebel on advance organisers formed the foundation upon which graphic organisers were built. It was proposed by Ausebel (1963) that a student's pre-existing knowledge, which is termed "cognitive structure" exerts a significant amount of effect on the student's ability to acquire new information. Learning takes place when an individual's cognitive structure is expanded by the incorporation of new information. Students are provided with the foundation for linking prior knowledge to newly acquired material through the use of visual organisers, which helps to make this process more manageable (Ausebel, 1963). Another cognitive theory that supported using graphic organisers in facilitating learning and retaining information is the Schema theory. Schema theory states that memory is composed of a network and that a schema is described as knowledge that is structured to facilitate the mental process. Winn and Snider (1996) described the characteristics of the schema theory as follows: 1. A schema is a well-organised structure that exists, is combined with other schemas in memory and has the sum of an individual's knowledge. 2. A schema is made up of links and nodes that explain the connections between node pairs. 3 Information that is general rather than specific is used to create a schema. 4. Schema provides contexts that help determine how new experiences are interpreted. Schema theory is where graphic organisers have their roots. Students need to be able to remember new information they learn to use it later (Dye 2000).

3. Method. Research Design

In this study, a quasi-experimental research design was adopted without randomization at the time of data collection. It involves one experimental and one control group with a pre-test and post-test non-equivalent group design. Both groups were exposed to the same pretest to assess their baseline abilities before the treatment. Graphic organisers were the teaching strategy used to teach the experimental group computer networks while the control group was taught the same topic via the traditional method. The two groups were exposed to post-tests after the treatment. Figure 1 Illustrations of qua-experimental research design for the two groups (As illustrated in Figure 1)

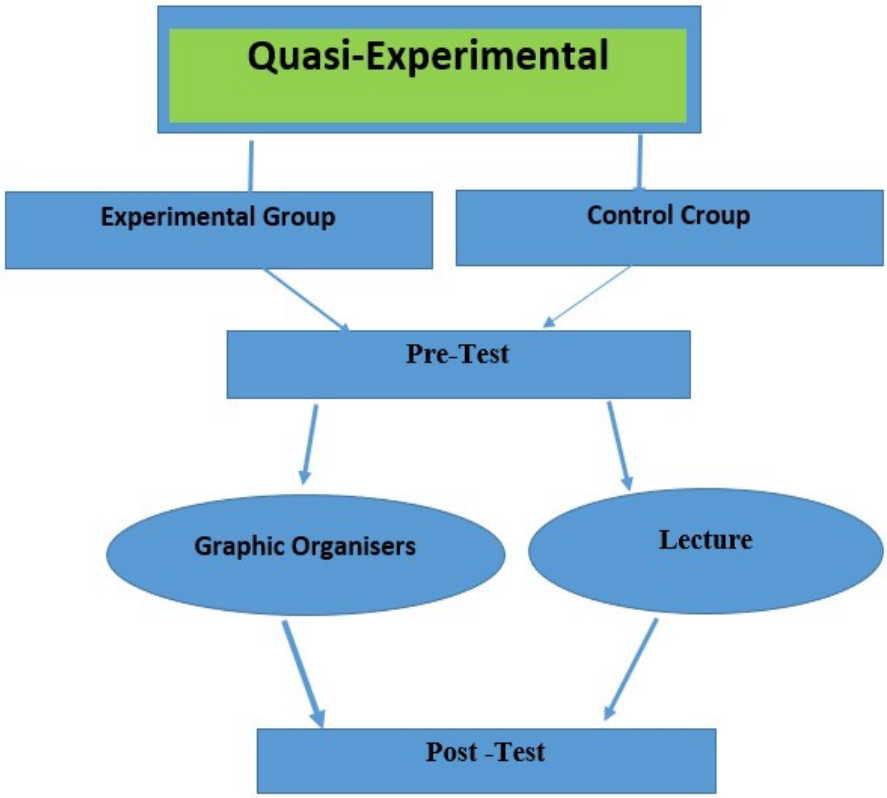

Figure 1: Showing the representation of experimental group and control group method

4.1 Population and sampling

This population is made up of all computer studies secondary school students in Education District V, Ojo Zone of Lagos State. Two public senior secondary schools were selected as the sample. This was because of two reasons. Presently, public schools have more equipped computer laboratories than private schools in Lagos State, Nigeria. This is because the government is now seeing the importance of ICT in national development. Most computers in public secondary schools are now connected to the internet in Lagos state, which was needed for teaching computer networks.

The total number of participants in this study was one hundred and five (105). Fifty-five (29 males and 26 females) students in the SS2 formed the experimental group while fifty (26 males and 24 females) students in the SS2 class formed the control group. Thus, the sample for the study was made up of students of mixed abilities, ages and genders.

4.2 Instrument

A self-developed instrument titled Computer Network Achievement Test (CNAT) was used for data collection. The questionnaire has two sections (A and B). The items in the instrument were taken from WASSCE past questions (2014–2020) and approved secondary school computer studies textbooks. The multiple-choice items assessed student performance. Computer studies teachers in Senior Secondary Schools with years of experience verified it. Teachers who coordinated and marked WASSCE were also considered for instrument validation. These respected persons were chosen to guarantee that the items' structure matched the scope, correctness, and logical presentation of the lesson plans' behavioural objectives. These efforts validated the instrument. Language specialists helped make the items unambiguous, grammatical, and ambiguity-free. Test-retest determined instrument reliability. The instrument was given to thirty-five (35) students who were not part of the respondents in the study. Each student's answer booklet was assessed for accuracy. After two weeks, the researchers administered the test again to the same set of students. The responses from the first and second administrations of the instrument were exposed to stability testing after collation. The reliability coefficient was r=.88. This indicates that the study instrument was reliable since the acceptable level is $r \geq 0.7$.

The experimental group and control group were given a pre-test to set a baseline prior to the treatment and a post-test using the same instrument. Afterwards, each group enjoyed the teaching methods assigned to the group to teach the topic “Computer Networks”.

The experimental group were taught computer networks using graphic organisers and adopted the following procedures as treatment

Step 1: The teacher uses a sample of a concept map to explain the computer network. This map contains to display the connections, through Wi-Fi or broadband, of the computers in a network.

Step 2: Students were guided on to how identify features of the concept map that can be seen in the classroom, such as a WI-FI router.

Step 3: Students state new vocabulary on the concept map and will generate their definitions based on their online research. Access.

Step 4: Students then generate their concept map using their definitions of new terms

Step 5: The class explores the variety of definitions used in the mind maps and will create a class set of definitions for key computer network terms

	Levene - test	df1	df2	Sig.

The control group were taught computer networks using the lecture method and adopted the following procedures
Step 1: The teacher briefly introduced computer networks to the students and gives various definitions of computer networks.
Step 2: The teacher supports the students in their understanding of computer network concepts.
Step 3: The teacher gives types and examples of computer networks.
Step 4: The teacher asks questions on the computer network.
Step 5: The teacher goes over the lesson again by laying emphasing on the salient points.
Immediately after the completion of the lessons. The teacher administered the achievement test (CNAT) to the two groups.
ANCOVA analysis was used on the post-test and the pre-test data.

Gender	**Graphic Organisers**		**Lecture Method**		**Total**	
	N	(%)	N	(%)	N	(%)
Male	29	52.7	26	52	55	52.3
Female	26	47.3	24	48	50	47.6
Total	55	100.0	50	100.0	105	100.0

4. Results

Table 1. Analysis showing gender and teaching strategy for the control and experimental groups

Table 1 shows the number of male students and female students in the graphicorganisers and lecture method groups. Population, normality, variance homogeneity and random assignment were the basic parametric assumption that are met before the data collected were analysed using analysis of covariance.

		Levene-test	dfl	df2	Sig.
Post-Achievement	Mean	.45	1	103	.51
	Median	.41	1	103	.53
	Median and with adjusted df	.41	1	82.25	.53
	trimmed mean	.65	1	103	.42
Pre-Achievement	Mean	.01	1	103	.92
	Median	.01	1	103	.92
	Median and with adjusted df	.01	1	99.04	.92
	Trimmed mean	.01	1	103	.92

Table 2: Analysis of Test of Homogeneity of Variances

Table 2 shows that both post-achievement and pre-achievement scores measures were not statistically significantly different. This confirmed that the variance between the groups is equal and passed the test of homogeneity of variance.

Research question one: Is there a significant difference in the academic performance of students taught computer networks using graphic organisers and lecture methods?

		N	Mean	Standard Deviation
Post – Achievement	Graphic	55	14.00	1.83
	Control	50	9.94	1.32
	Total	105	12.17	2.59
Pre – Achievement	Graphic	55	5.38	2.14
	Control	50	5.84	2.03
	Total	105	5.60	2.09

Table 3: Mean of graphic organisers and lecture method groups

From Table 3: Students' achievement mean scores before the administration of treatment for the control group (M = 5.84) which was higher than the experimental group (M = 5.38). However, after the administration of the treatment, the mean score of the experimental group (M = 14.00) became higher than the control group (M = 9.94).

Hypothesis one: There is no statistically significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	955.48[a]	2	477.74	42.52	0.00
Intercept	1509.71	1	1509.71	134.38	0.00
Pretest-Achievement	.01	1	.01	0.00	0.98
Group	944.47	1	944.47	**84.07**	0.00
Error	1145.91	102	11.23		
Total	15094.00	105			
Corrected Total	2101.39	104			
Note: R Squared=.455 (Adjusted R Squared =0 .444)					

Table 4: ANCOVA Table Showing Post-test Achievement with Pre-test Achievement as Covariate

Table 4 shows that the pre-test achievement of the P-value is 0.00. This shows that students in graphic organisers and lecture method groups have different initial entry levels, which is what the Pretest intended to achieve. The ANCOVA brings all the students to the same baseline.
The result from the analysis of covariance showed no statistically significant difference in the academic performance of students taught computer networks using graphic organisers and those taught with lecture methods (**F (1,102) = 84.07; P<0.05).** Thus hypothesis one then is **REJECTED**.

Research question two: Is there a significant difference in the academic performance of male and female students taught computer networks with graphic organisers and the lecture method?

Gender	Mean Scores	Standard Deviation	N
Male	11.20	4.81664	55
Female	11.04	4.15987	50
Total	11.1238	4.49507	105

Table 5: Mean and Standard Deviation of Male and Female Students in Graphic Organisers and Lecture method groups

Mean scores of students in the experimental group (11.20) and the control group (11.04) based on their gender, which shows no statistically significant difference.

Hypothesis two: there is no statistically significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods based on gender.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12.507[a]	2	6.253	.305	.738
Intercept	1828.062	1	1828.062	89.264	.000
Pretest_Achivement	11.836	1	11.836	.578	.449
Gender	1.495	1	1.495	.073	.788
Error	2088.884	102	20.479		
Total	15094.000	105			
Corrected Total	2101.390	104			
NOTE	**A. R Squared = .006 (Adjusted R Squared = -.014)**				

Table 6: ANCOVA Table Showing Students' Gender on Posttest Achievement and Pretest Achievement as Covariate

Table 6 shows a statistically significant difference in the academic performance of students taught computer networks using graphic organisers and lecture methods based on gender as **(F (1,102) =0.07; p>0.05)**. Thus hypothesis two is then **NOT REJECTED.**

5. Discussion

The first hypothesis finds out whether "there is no statistically significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods". The results show a statistically significant difference in the performance of those taught computer networks using graphic organisers and lecture method, thereby rejecting the null hypothesis. The finding from this study support the potency of the graphic organisers in enhancing the teaching and learning of computer networks than using lecture method. This finding agrees with the other studies by Pantziara et al (2009); Butler, et al, (2003); and Witzel et al., (2003)) which also provided evidence attesting to the efficacy of graphic organisers in promoting the students' academic performance. Also, the result agrees with the finding of Van Gelder, (2007) who agreed that visual displays enhance learning as it has positive impact on students' academic achievement

since the experimental group performed better than their counter in the control group. However, the finding did not support that of Baxendell (2003) and Egan (1999) who believed that the usage of graphic organisers in the teaching will make students become tangled and disorgansed in understanding some concepts.

The second hypothesis is that "there is no statistically significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods based on gender". The result revealed that there is no statistically significant difference between the academic performances of students based on gender; thus the hypothesis was not rejected.

Our findings agree with the studies of Githua and Nyabwa (2007); Zollman (2006) and Odewumi and Gambari, (2019). Their studies found that there is no statistically significant difference in the academic performance of students taught with graphic organisers based on gender. This also concur with the results of (Foxworthy, 1995; Manning, 1998) where they found out that all students benefited equally irrespective of their gender when graphic organisers were used to teach concepts in mathematics. However, our result did not concurs with that of Owolabi and Adaramati, (2015) because they found significant differences in the academic performance of male and female students. The intervention seemed to be more favourable to male students than the female students.

Generally, this study has shown that the use of graphic organisers motivates the student to learn faster. Students find computer networks more exciting and interesting to learn with the use of graphic organisers. The findings also reveal that gender has no bearing in the academic performance of the students Thus, graphic organisers should be integrated into the teaching and learning of ICT concepts.

6. Conclusion

This study's findings showed that graphic organisers are more effective in teaching and learning computer studies when compared to the lecture method which is a common method used by teachers for many years. Quasi-experimental was used to test the two hypotheses in this study (i.) no significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods. (ii.) no significant difference in the students' academic performance taught computer networks using graphic organisers and lecture methods based on gender.

In this study, the result of comparing graphic organisers and the lecture method using ANALYSIS OF COVARIANCE showed significant results $[F\ (1,102) = 84.07;\ P< 0.05]$. This shows a statistically

significant difference in the academic performance of the experimental group and control group. This implies that the experimental group was significant which implies that graphic organisers are a better model to adopt for teaching effectively in order to enhance the students' understanding of computer networks as one of the difficult concepts in computer studies.

This study also revealed that statistically, there is no significant difference in the academic performance of male and female students taught computer networks using the methods. [*F (1,102) = 0.07; P>0.05]*

Finally, these findings have shown the effective use of graphic organisers in teaching computer networks at secondary school levels and this need to be adopted in order to increase the academic performance of learners at both internal and external examinations.

7. Recommendations

The researchers recommended as follows:

1. Teachers should be encouraged and trained to use graphic organisers in teaching of computer studies and other ICT - related concepts.
2. Government should train teachers through seminars, conferences and workshops on the importance of using graphic organisers in schools.
3. There should be an Educational Resources Centre (ERC) by the Ministry of Education across the country where visual instructions would be made for teachers to purchase.
4. Further research or studies should be made to address the barriers or challenges facing teachers on the use of graphic organisers in their daily classrooms in schools.

8. Ethical consideration

There was an approval from the appropriate authorities of the schools used —principals of public schools —was requested in order to conduct the study in those schools. Every participant were asked to sign a consent form located on the answer booklet, the research team ensured that there was an agreement with everyone to take part in the study. The participants informed about the goals of the study and were all given the assurance that all their responses would be kept private and used for only for research. They were also made to understand that participation in the research is voluntary and that participants have the right to leave the study at any time, for any reason. In addition to this all the respondents were not physically or psychologically hurt or abused while participating in the study.

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There was no conflict of interest with the authors
9.2 Funding
The authors received no financial support for this study
9.3 Data Availability
Data will be made available on request.

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