

## Effects of Graphic Organizer and Experiential Learning with Feedback on Students' Achievement and Retention in Basic Science and Technology, Plateau State, Nigeria.

ASABE EDWARD BASH  
University of Jos, Nigeria

SERAPHINA M.C KURUMEH, REGINA MARITA O SAMBA  
Benue State University, Makurdi, Nigeria

**Abstract.** The study investigated the effects of graphic organizer and experiential learning with feedback on students' achievement and retention in Basic Science and Technology, Plateau State., Nigeria. Three research questions were answered and two hypotheses were tested at 0.05 level of significance. The study adopted a quasi- experimental design. Specifically, the separate sample pre-test post-test design. The population of the study comprised of 13,040 with a sample of 325 junior secondary two students from six secondary schools in Zone B of Plateau State, Nigeria were selected using a multi-sampling technique, specifically the purposive sampling technique. The Basic Science and Technology Achievement Test (BSTAT) with reliability coefficient of 0.745 was used for data collection. The data collected was analyzed using Mean and Standard Deviation to answer the research questions While Analysis of Covariance (ANCOVA) was used in testing the hypotheses at 0.05 level of significance. The findings revealed that there were significant differences in both graphic organizer and experiential learning achievement with a mean score ( $\bar{X}$  = 25.94, SD = 9.02) and group II had a mean score of ( $\bar{X}$  = 29.01, SD = 10.08 before treatment. After treatment the results for experimental group II yielded a higher mean score ( $\bar{X}$  = 61.54, SD = 9.64) than experimental group I ( $\bar{X}$  = 50.24, SD = 14.62). The mean difference is high with 8.23. On the investigation on gender, there was also significant difference in the mean achievement of male and female, in favour of female. It was recommended among others that the two strategies can be used for teaching of Basic Science and Technology to enhance high achievement in Basic Science and Technology achievement and enhancement of retention in students. Furthermore, stake holders should organize seminars and workshops to train teachers on how to

use graphic organizer and experiential learning with feedback for teaching.

**Keywords:** Effect, Graphic organizer, Experiential learning, Basic Science and Technology, Gender, Retention.

### 1. Introduction

Science and Technology constitute the fountain of national growth, development and productivity. Science as a discipline is considered as the systematic study of knowledge of man and his environment, which depends on seeing and testing of facts (Mankilik, 2014). The researcher explains further that technology is the practical use of scientific knowledge and techniques to produce goods and services to meet human needs. Science and Technology have been instrumental in shaping and improving the life of humanity. Samba (2010) opined that science is the foundation of sustainable development and a key to national economic growth and prosperity. Through Science and Technology, modern gadgets in all aspects of human endeavors have been invented, like electricity, aircraft, television, computers, medical kits, agricultural machines among others. Similarly, through Science and Technology, developed nations of the world like America, China, Germany and France, among others, boast of scientific inventions and innovations, which make those countries to be rated as world powers (Human Development Index, 2015 & 2016). Thus, Science and Technology is undeniably the bedrock of sustainable economic growth and development of any nation.

The importance of Science and Technology to national development cannot therefore be over-emphasized, as development at any phase is always

linked with technology and this can only happen when there is advancement in science. In recognition of the impact of Science and Technology to all national development, the Federal Government of Nigeria (FGN) places much emphasis on the teaching and learning of Basic Science and Technology in schools especially at the basic education level. Consequently, Basic Science and Technology was introduced at the junior school level as the foundation to other sciences. Federal Ministry of Education (FME, 2012) has listed the objectives of teaching Basic Science and Technology subject as follows: to enable the learners develop interest in Science and technology; acquire basic knowledge and skills in science and technology; apply scientific and technological knowledge and skills to meet contemporary societal needs; take advantage of the numerous career opportunities provided by science and technology; become prepared for further studies in science and technology; avoid drug abuse and related vices, and be safety and security conscious. The ministry explains further that the objectives of Basic Science and Technology subject is geared towards promoting creativity and critical thinking in the learner, helping the learner to appreciate the contemporary and changing world for better, developing the spirit of entrepreneurship among others. Mbanefo (2016) affirms that challenges of the 21<sup>st</sup> century, with its complex environmental, social and economic pressures require young people to be creative, innovative, enterprising and adaptable with confidence and skills to use their critical and creative thinking purposefully. These attributes are incorporated in the Basic Science and Technology curriculum, which makes it very important at this time that the nation is faced with myriad of youth problems like youths' restiveness, unemployment, and drug abuse among others. The attainment of the Basic Science and Technology objectives will help in laying a sound foundation for future engineers, physicians, computer scientist, architects and others, who will propel the nation to greatness among developed nations. It will also build a nation that the citizens will be free from drug abuse, with a resultant effect of a crime free society (STAN, 2011).

In spite of the importance of the subject to the development of the youths and the nation at large, students' achievement in the subject has not been encouraging. Analysis of Basic Education Certificate Examination (BECE) in Basic Science and Technology in Plateau State from 2012-2018, reveals percentage credit pass as 26.49%, 24.80%, 18.06%, 17.15%, 23.82% (Plateau State Ministry of Education, 2017) Appendix D. One of the problems that are generating public concern and outcry in Nigeria today of course is this decline in the

achievement of students. The BECE Chief Examiners' reports for the years also decry this trend from 2012 to 2018.

Many factors have been attributed to the underachievement of students in Basic Science and Technology in BECE and the one that is most common is poor teaching methods (Akinmade, 2011). Explaining further, Mbanefo (2015) revealed that one of the challenges of creative thinking skills in Basic Science and Technology students is that the teachers are not adequately prepared to teach the students using appropriate instructional methods. Adegoke (2010) observed that the conventional lecture strategy is usually the dominant approach used by teachers in Nigeria and students are not actively involved in developing knowledge; they generally remain passive listeners throughout the lesson. Hence, the strategy is mainly a teacher-centered approach to learning Basic Science and Technology and learners are mainly passive in the teaching and learning process.

In view of the lapses inherent in the conventional lecture strategy of teaching Basic Science and Technology and subsequent low achievement by students, researchers in science and technology are continually making efforts towards finding ways of improving students' achievement in Basic Science and Technology. Studies by Hassan, Kareen, Bala and Abba (2016), Samba, Kurumeh and Bash (2018), Bash, Kabang and Dawal Josiah (2019) have shown that some teaching techniques such as the use of computer animated approach, inquiry approach, problem-based approach, peer tutoring approach, target task approach, jigsaw cooperative learning amongst others have been applied to tackle the poor achievement of students in Basic Science and Technology. Similarly, government and other professional bodies like Science Teachers Association of Nigeria (STAN) have been organizing training and re-training workshops for science teachers with the aim of improving their instructional delivery capacity and by expanding students' academic achievement in the field. In order to achieve the stated objectives in the Basic Science curriculum, teaching / learning strategies that are learner- centered and activity- based oriented. Keswet, Bash and Kabang (2016), state that science teaching /learning need to be seen as a necessary tool for the full realization of human being especially at the basic level. When there is increase in the scientific knowledge among the students right from the Primary level it will help students to learn the rudiment of science thereby improve the achievement of students.

It is an acceptable fact that teachers are not born but they can be made through effective learning and

interest in what they learned and what they teach. Sequeira (2012), states that good teachers nurture their knowledge and skills through constant and deliberate efforts. One of the prerequisite to be good teacher is to understand the teaching learning process in a more depth manner. It is against this background that this study sort to compare the effect of graphic organizer and experiential learning with feedback on students' critical thinking and achievement in Basic Science and Technology, with the aim of identifying the most suitable teaching strategy as researches has attributed students' underachievement in the subjects to teachers teaching techniques. Tsoho (2010) also identifies teaching strategy as main key to retention in students on learnt materials. In conformity with the above statement, Chianson, Kurumeh and Obida (2010) found in a study that, teacher serve as a standard to students retention in mathematics and science concepts. The researchers further explained that the teaching strategies that involve active participation of students enhance retention. Despite these efforts, little or no appreciable improvement has been recorded in students' achievement in Basic Science and Technology subject

Graphic organizers are visual representations, models, or an illustration that depicts relationship among the key concepts involved in a lesson units or learning task. Studies have shown that meaningful learning can be assisted using GOs (Pantzaira, Gagatsis & Elia, 2009; Oliver, 2009; Kansizoglu, 2017). However, much has not been done in the area of graphic organizer in enhancing students' academic achievement in this part of the world. Hence, this study will find out whether graphic organizer could improve students achievement and retention in Basic Science and Technology.

In experiential learning, personal experience is the central point for learning; it allows students to test the validity of the ideas that were created during the learning process. William (2010), experiential learning is like taking students to the zoo to observe or interact with the animals, instead of reading about them from a book. Thus, students discover knowledge and have their own experience instead of hearing or reading about others experiences from books or stories from friends and relations. Studies have shown that experiential learning can improve students' achievement.

In addition, studies on academic achievement of students in Basic Science and Technology have also shown that gender is one of the major factors that affect students' academic achievement. Gender here, means male and female learners in a Basic Science

and Technology classroom. Some researchers are of the view that male students achieve better than the female in science and technology (Nwachukwu, 2011) Other researchers opined that female students achieve better (Kathleen, 2009; Iorlamen, 2017). Yet some researchers like Gberkon, 2014, found that both male and female students achieve equally. This is an indication that the existing accounts fail to resolve the contradiction between male and female academic achievement in the subject. Therefore, there is the need for further investigation, more so that Jacob and Linus (2017) found that, instructional method used in the classroom may influence gender and students achievement in Basic Science and Technology. Hence, the current study will compare the effects of graphic organizer and experiential learning strategies on students' achievement and retention in Basic Science and Technology to find the effect size of the two groups under study. This could help to identify between the two teaching strategies that may enhance the achievement and retention of both male and female students in Basic Science and Technology.

## 2. Research Questions

To achieve the above objectives, the following research questions were raised to guide the study:

- What is the mean achievement scores of students when taught using graphic organizer and those taught experiential learning with feedback?
- What are the mean retention scores of students taught Basic Science and Technology using graphic organizer and experiential learning strategies?
- What are the mean retention Scores of male and female Students taught Basic Science and Technology using graphic organizer and experiential learning with feedback?

## 3. Hypotheses

To achieve the above objectives, the following hypotheses were raised to guide the study:

- There is no significant interaction effect of methods and gender on the mean achievement scores of Basic Science and Technology students taught using graphic organizer and experiential learning with feedback
- There is no significant difference in the mean retention scores of male and female students taught Basic Science and Technology with graphic organizer with feedback strategy.

4. Results

**Table 1:** Mean and Standard Deviation of Achievement Scores of Students in Experimental Groups I and II

Group	N	Pretest		Posttest		Mean Gain	$\bar{X}_{Diff}$
		X	SD	X	SD		
Experimental I	153	25.94	9.02	50.24	9.64	24.30	8.23
Experimental II	172	29.01	10.08	61.54	14.62	32.53	

Table 1 reveal the mean and standard deviation of post-test mean achievement scores of the experimental groups I and II. The result for experimental group I yielded a mean score ( $\bar{X}$ = 25.94, SD = 9.02) and group II had a mean score of ( $\bar{X}$  = 29.01, SD = 10.08) before treatment. After treatment the results for experimental group II yielded a higher mean score ( $\bar{X}$  = 61.54, SD = 9.64) than experimental group I ( $\bar{X}$ = 50.24, SD = 14.62). The mean difference is high with 8.23 for experimental groups I and II was low though higher mean gain experimental group II. This could be because both groups were exposed to treatment. The result further shows that those taught with experiential learning performed better than those taught using graphic organizer with feedback.

**Table 2:** Mean and Standard Deviation of Retention Scores of Male and Female Students in Experimental Group I (Graphic Organizer)

Gender	N	Pretest		Retention		Mean Gain	$\bar{X}_{Diff}$
		X	SD	X	SD		
Male	72	25.81	8.99	45.24	9.11	19.43	3.07
Female	81	26.10	9.12	48.60	8.18	22.50	

Table 2 shows the mean and standard deviation of pre-test and retention mean scores of male and female students taught Basic Science and Technology using graphic organizer with feedback. The mean scores for gender (male and female) was, male ( $\bar{X}$  = 25.81; SD = 8.99) and female ( $\bar{X}$  = 26.10; SD = 9.12) before treatment. The retention test shows that with male ( $\bar{X}$  = 45.24; SD = 9.11) and female ( $\bar{X}$  = 48.60; SD = 8.18), it indicates that the mean retention score of male differ from that of female with a mean difference of 3.07. This implies that female students retained what was learnt better than their male counterparts in Basic Science and Technology when taught using graphic organizer with feedback.

What are the mean retention scores of students taught Basic Science and Technology with experiential and graphic organizer strategies with feedback?

**Table 3:** Mean and Standard Deviation of Retention Scores of Students in Experimental Groups I and II

Group	N	Pretest		Retention		Mean Gain	$\bar{X}_{Diff}$
		X	SD	X	SD		
Experimental I	153	25.94	9.02	44.20	10.54	18.26	0.75
Experimental II	172	29.01	10.08	46.52	12.51	17.51	

Table 3 reveal the mean and standard deviation of post-test mean achievement scores of the experimental groups I and II. The result for experimental group I yielded a mean score ( $\bar{X}$ = 25.94, SD = 9.02) and group II had a mean score of ( $\bar{X}$  = 29.01, SD = 10.08) before treatment. After treatment the results for experimental group II has retention mean score ( $\bar{X}$  = 44.20, SD = 10.54) and experimental group I ( $\bar{X}$ = 46.52, SD = 12.51). The mean difference is low with 0.75. This could be because both groups were exposed to treatment. The result further shows that those taught with experiential learning had almost the same retention mean score as those taught using graphic organizer with feedback.

**Table 4:** Summary Result on Interaction Effect of Method and Gender on the Mean Achievement Scores of Students taught Basic Science and Technology using graphic organizer and experiential learning with feedback

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5716.69 <sup>a</sup>	4	1429.17	15.87	.00	.17
Intercept	101094.95	1	101094.95	122.57	.00	.80
Preachievement	92.44	1	92.44	1.03	.31	.00
Group	5711.79	1	5711.79	63.43	.00	.17
Gender	3.60	1	3.60	.04	.84	.00
group * Gender	46.16	1	46.16	.51	.48	.01
Error	28818.08	322	90.06			
Total	904517.00	325				
Corrected Total	34534.77	324				

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5716.69 <sup>a</sup>	4	1429.17	15.87	.00	.17
Intercept	101094.95	1	101094.95	122.57	.00	.80
Preachievement	92.44	1	92.44	1.03	.31	.00
Group	5711.79	1	5711.79	63.43	.00	.17
Gender	3.60	1	3.60	.04	.84	.00
group * Gender	46.16	1	46.16	.51	.48	.01
Error	28818.08	322	90.06			
Total	904517.00	325				
Corrected Total	34534.77	324				

a. R Squared = .166 (Adjusted R Squared = .155)

The Basic Science and Technology achievement data were subjected to a one-way analysis of variance having two levels of gender (male, female) and method. The interaction effect of methods and gender on Basic Science and Technology achievement yielded, male (M = 56.11; SD = 10.34) and female (M = 56.61; SD = 11.75);  $F(1, 320) = 122.16, p > 0.05$ . Since the p value of 0.48 is greater than the 0.05 level of significance the null hypothesis was retained. This indicates that the achievement mean score of male students in Basic Science and Technology do not significantly differ from that of female. The result reveals that the interacting effect of methods and gender was statistically insignificant on students' crit.

There is no significant difference in the mean retention scores of students taught Basic Science and Technology with graphic organizer and experiential learning with feedback strategies.

**Table 5:** Summary Result of ANCOVA on Mean Retention Scores of Students taught with Graphic Organizers and those taught using Experiential Learning with Feedback.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4663.7 <sup>a</sup>	2	2631.87	31.58	.00	.26
Intercept	91374.80	1	101374.80	1130.64	.00	.68
Pre-Achievement	81.94	1	81.94	1.03	.31	.00
Group	4661.09	1	4661.09	43.14	.00	.20
Error	28871.03	322	89.66			
Total	804517.00	325				
Corrected Total	24534.77	324				

a. R Squared = .174 (Adjusted R Squared = .169)

Analysis of Covariance (ANCOVA) was conducted to determine if a significant difference exists in the retention mean score of experimental group I and experimental group II. Table 14 shows that  $F(1,324) = 43.14, p < 0.05$ , since the p value of 0.00 is less than 0.05 level of significance, the null hypothesis was rejected, indicating that there was a significant effect of graphic organizer and experiential learning with feedback on students' retention in Basic Science and Technology. The result further reveals an adjusted R squared value of .169 which means that 16.9 percent of the variation in the dependent variable which is students' retention score in Basic Science and Technology is explained by variation in the treatment, while the remaining is due to other factors not included in this study.

### 5. Methodology

The study employed a quasi-experimental design. Specifically, the study adopted a separate sample pretest posttest design. Quasi-experimental is a design where a researcher uses intact class and does not always try to provide full experimental and control group through randomization (Emaikwwu, 2015) However, there are many situations specially in educational research which it is not possible to conduct a true experiment because neither full control over the scheduling of experimental condition nor randomization can always be realized. This design has no control group, and no randomization was applied on getting the samples for the experimental I and experimental II groups. A pre-test was administered to both experimental groups to determine if any difference exists in the ability of the

two groups before treatment. Both experimental groups received separate and different treatments after which a post-test was administered to both the experimental groups thereafter. The population of the study is all the junior secondary school in zone B of Plateau State which is 13,040 junior secondary school two (JSS II). 325 junior secondary two ( Basic Science and Technology students made up of 164 males and 161 females from two secondary schools in Zone B of Plateau State formed the sample for the study. Basic Science and Technology Achievement Test (BSTAT) with reliability coefficient of 0.71 were used to test the reliability of the instrument. The instrument was an objective question with 40 multiple choice of four options A, B, C and D. Three research questions and two null hypotheses tested at 0.05 level of significance guided the study. Data collected was analyzed using mean and standard deviations to answer the research questions while Analysis of Covariance (ANCOVA) was used in testing the hypotheses. ANCOVA was used in this study to test the significant differences or control the initial difference between groups with the pretest serving as covariates.

## 6. Discussion

The findings on the mean achievement scores of students revealed the mean achievement scores of Basic Science and Technology using graphic organizer experiential learning with feedback, experiential learning yielded a higher mean score than those taught using graphic organizer. The finding affirmed the study of Adams (2010) who investigated the effect of experiential learning teaching method on the achievement of junior secondary school students in Basic Science and Technology. The result revealed that the experiential learning teaching methods is superior to the conventional method in facilitating achievement in Basic Science and Technology. Furthermore, the findings on the mean retention scores of students taught Basic Science and Technology using graphic organizer and experiential learning strategies with feedback, the finding revealed that there was a significant effect of group on students 'retention when taught Basic Science and Technology using graphic organizer and experiential learning in the post-post result. The finding showed that experimental group II (experiential learning) achieved higher than experimental I (graphic organizer). The result of the study can be concluded that the experiential learning strategy is useful to improve retention ability of students. This post –test result is in line with that of Adams (2010) who investigated the effect of experiential learning

teaching method on the achievement of junior secondary school students in Basic Science and Technology as in the post field result which revealed that the experiential learning teaching methods is superior to the graphic organizer in facilitating achievement in Basic Science and Technology. A possible reason for this similar result as in the post-field may be that the experiential class enjoyed the way they were taken outside the classroom to find out things for themselves and were also allowed to share their experiences with one another. It could also be because the questions for pre- test, post-test and the post-post test were same, so it was likely to be a work over for the students.

Another finding on gender in the post-post result in this study was that there was no significant effect in the retentive ability of male and female students taught Basic Science using graphic organizer and experiential learning strategies. This finding is in agreement with the findings of Godpower-Echie and Owo (2019) who found no significant difference in the retention of male and female taught Basic Science using inquiry-based method of teaching. The study however, contradicts that of Owdunni and Ogundola (2013) who found that boys scored higher than female in ability to retain science concepts than girls using inquiry method of teaching.

## References

- Akinmade, C. T. O. (2011). *Effective teaching of STM subjects in secondary schools*. A Book of Reading of Plateau State Science Teachers Association of Nigeria, 1, 28-45.
- Adams, L. B. (2010). The effects of experiential teaching method versus lecture method on students' achievement. A Master's thesis submitted to the Graduate Faculty of University of Georgia. Retrieved on 24/05/2018 on [www.ovpr.uga.edu/hso/](http://www.ovpr.uga.edu/hso/).
- Adegoke, B. (2010). Integrating animations narrations and textual materials for improving students learning outcomes in senior secondary school physics. *Electronic Journal of Research in Education Psychology*, 8(20), 725-748. Retrieved from <http://investigacion-psicopedagogica.org>.
- Bash, A.E, Kabang, B.A, Dawal, B.A & Josiah (2019) Target Task Approach as an Innovation for Improving Students' Achievement and Interest on BASIC Science and Technology. *60<sup>th</sup> Annual Conference Proceedings of STAN Nigeria*, Kano.

- Chianson, M. M, Kurumeh, M.S, Obida, J. A. (2010). Effect of cooperative learning strategy on students retention in circle geometry in secondary schools in Benue State, Nigeria. *American Journal of the Scientific and Industrial Research*, 2(1)33-36.
- Emaikwu S.O (2015). *Fundamentals of Research Methodology and Statistics*. Selfers Academic Press Ltd. Makurdi: Benue State. ISBN: 978-3-659-29670.3
- Godpower-Echie, G.& Owo, W.J (2019) Gender Differences in Basic Science Achievement of Junior Secondary School Students in Obio/ Akpor Local Government Area, River State. *International Journal Scientific Rsearch in Education*. 12(2), 320 329.
- Human Development Index (2015). Retrieved on 14/03/15 from <http://hdr.undp.org/en/content/human-development-index-hdi>
- Iorlamen, I. C. (2017). *Effects of algebra tiles manipulative on the achievement and interest of junior secondary schools students in algebra in Kuji Area Council Abuja*. Unpublished M.Ed. Thesis, University of Jos.
- Kansizoglu, H.B. (2017). The effect of graphic organisers on language teaching and learning areas: Ameta-analysis. *Education Science*, 42 (191), 139-164.
- Kathleen, H. (2011). *Gender gap: More female students than males attending universities*. Retrieved on 13/06/2018, from [www.ucdavis.edu](http://www.ucdavis.edu).
- Keswet, L.A, Bash, A.E & Kabang B.A (2016) Poverty and Children Health care: Implication for Teaching and learning of science and Technology. *AsiaPacific, Journal of Multidisciplinary Research* 4(4) 92 – 96
- Mankilik, M. (2014). *Innovation in science technology and mathematics*. A Book of Reading of Plateau State Science Teachers Association of Nigeria, 2, 1-8.
- Mbenefo, M.C. (2015). *Developing creative thinking skills in basic science teachers association of Nigeria*, 50 (10), 207-216.
- Nwachukwu, O. P. (2011). Gender difference in physics achievement in senior secondary school in to Local Government Area of Delta State. *National Association of Science Humanity and Education Research Journal*, 9, 9-12.
- Owodunni, A.S & Ogundola I.P (2013) Gender in Achievement and Retebtion of Nigeria Students exposed to concept of science through reflective Inquiry Instructional Technique. *British Journal of Education, Society and Behavioural Science*. 3(4) 278-295.
- Pantzaira, M., Gagatsis, A., & Elia, I. (2009). Using the diagram as tools for solution of non-routine mathematics problems. *Educational Study Math*, (72), 39-60.
- Sequeira, A. H. (2017). *Introduction to teaching concept and learning*. National Institute ofTechnology Karnataka, Surathkal, India. Hhp://ssm.com/abstract=215066.
- Tsoho, I.t.w. (2011). Effects of problem solving and students centered teaching strategies on students' geometry performance and retention in junior secondary schools in Kano State. An Unpublished M.ED. Thesis of the Ahmadu Bello University, Zaria.