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ORIGINAL ARTICLE

Fostering Students' Critical Thinking and Achievement in Basic Science Using Graphic Organizer and Experiential Learning Strategies with Feedback

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ABSTRACT

The study investigated the effects of graphic organizer (GO) and experiential learning (EL) with feedback on the mean achievement and students' critical thinking in Jos North Local Government Area of the Plateau State of Nigeria. A pre-test post-test quasi-experimental design was used. A sample of 75 students was drawn from the population of 1950 junior secondary (JS) two students. Two instruments, the Basic Science and Technology Achievement Test (BSTAT) and a critical thinking test (CTT), were used for data collection. The respective reliability coefficient values of 0.81 and 0.79 were obtained using an item response theory three parameter logistic model. The statistical tools used for data analysis were mean and analysis of covariance (ANCOVA). Results revealed that students taught using GO had a mean gain of 12.99 while students taught using EL had mean gain of 12.02 in the BSTAT. ANCOVA analysis of post-test mean scores in the BSTAT, $F(1, 58) = 1.282$, $\rho > 0.05$, was not significant. Furthermore, ANCOVA analysis between mean post-test scores of the CTT for GO and EL groups $F(3, 81) = 2.236$, $\rho > 0.05$, was not significant. GO an EL with feedback strategies enhanced students' achievement and critical thinking with GO being slightly superior. Both strategies are recommended for use in teaching Basic Science and Technology.

KEY WORDS: graphic organizer strategy; experiential learning strategy; critical thinking; achievement in basic science and technology; feedback

INTRODUCTION

Science and technology constitute a source of national growth, development, and productivity. According to Mankilik (2014), 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. He 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. Corroborating this view, Samba (2010) affirms 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 comfort have been invented, such as electricity, aircraft, television, computers, medical kits, and agricultural machines, among others. Similarly, through science and technology developed nations of the world such as America, China, Germany, France, and so on boast of scientific inventions and innovations, which make them to be rated as world powers. Thus, science and technology is a bedrock of sustainable economic growth and development of any nation (Samba, 2010).

In recognition of the impact of science and technology to national development, the Federal government of Nigeria has placed emphasis on the teaching and learning of science and technology in schools especially at the basic education level (that is, the first 9 years in formal school). Consequently, basic science was introduced at the basic school level as the foundation to other sciences. The objectives of teaching basic science and technology subject are: 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 (FRN, 2014). The document explains further that the objectives of science and technology subjects are geared toward promoting creativity and critical thinking in the learner. Thus, helping the learner to appreciate the contemporary and changing world better and help in developing the spirit of entrepreneurship among others. Mbanefo (2016) argued that, the challenges of the 21st century, with its complex environmental, social and economic pressures require young people to be creative, innovative, enterprising, and adaptable; exhibiting confidence and skills that enable them employ critical and creative thinking purposefully. All these attributes

are incorporated in the basic science and technology curriculum (FME, 2012), thus making it relevant in the 21st century in preparing youths to meet global challenges. 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 in which the citizens are formidable able to take their stand in world affairs.

In spite of the importance of basic science and technology subject to the development of the youths and national development, students' achievement in the subjects has not been encouraging. Analysis of Basic Education Certificate Examination (BECE) in basic science and technology the Plateau State from 2012 to 2016, reveals percentage credit passes of 22.86%, 56.44%, 21.06%, 13.69%, and 23.82%, respectively (Plateau State Ministry of Education, 2017). These results impact on those students who would naturally have read science and technology related courses in higher levels as they may be forced to drop science in favor of non-science related courses. This in the long-term would not be of benefits to either the students or the nation.

According to BECE Chief Examiners' reports from 2012 to 2016, there has been consistent poor performance in the topics "habitat" and "ecology." These are topics in the Junior Secondary School Two curriculum (FME, 2012). Many factors have been attributed to the under-achievement of students in basic science and technology in BECE, and one of the most prevalent reason put forward is the poor teaching methods used by teachers (Akinmade, 2011; Anyaegbunam, 2012; Mbenefo, 2015). Explaining further, Mbenefo (2015) revealed that one of the challenges of developing creative thinking skills in basic science students is that the teachers are not adequately prepared to teach the students, using appropriate instructional methods. Adegoke (2010) observed that the conventional lecture method is the dominant approach used by teachers in Nigeria. This teaching method does enable students to be active participants in learning process and hence the students are generally passive in the learning process. The lecture method which is mainly teacher-centered approach does not help the students think as they are often not involved in the learning process. It is therefore grossly inappropriate in fostering science skills and critical thinking.

In view of the lapses inherent in the conventional lecture method of teaching science and technology, resulting in and low performance by students in the subject, researchers in science and technology are continually proffering ways of improving students' achievement in science and technology. Studies (for example, Agbo and Taukek, 2011; Lakpini and Atedoga, 2013; Sani and Nsofor, 2013; Dauda, 2014) have shown that some teaching techniques such as the use of computer animated approach, inquiry approach, technology and problem-based learning approach, and peer tutoring approach have been applied to tackle the poor achievement of students in science and technology. Similarly, government and other professional bodies such as Science Teachers Association of Nigeria have been organizing training and re-training workshops for science teachers with the aim of improving their instructional delivery capacity and by extension students' academic achievement in science.

Despite these efforts, little, or no appreciable improvement has been recorded in students' achievement in science and technology subjects. Therefore, there is the need to adopt newer innovative learner-friendly instructional strategies in improving students' achievement in science and technology subjects. It is against this background that this study sought to compare the effect of graphic organizer (GO) and experiential learning (EL) with feedback on students' critical thinking and achievement in basic science and technology. This was with the aim of identifying a more suitable teaching strategy of the two, as several research studies have attributed students' underachievement in the science subjects to poor teaching techniques (Samba et al., 2010; Achor and Agamber, 2016; Achor et al., 2018). Therefore, two teaching techniques: GO and EL with feedback were used for the study to determine their effect on students' achievement and critical thinking.

GO is simply a graphical or spatial representation of the text concept. It is an instructional tool that can help students to organize or structure information and concept to relate with other concepts. According to Ellis (Zaini et al., 2010), the spatial arrangement of GO's allows the students to identify the missing information or absent connections in one's critical thinking. Studies have shown that meaningful learning can be assisted using GO's (Pantzaira et al., 2009; Samba, 2010). EL, on the other hand, is learning by doing or learning through experience (Northern Illinois University, 2011). In EL, personal experience is the central points for learning; it allows learners to test the validity of the ideas that were created during the learning process. According to Wurdinger and Carlson (2010), EL 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. Studies have shown that EL can improve students' critical thinking as well as academic achievement (Wurdinger and Carlson, 2010). Furthermore, feedback is an act of providing students with information about success and failure of their academic achievement by the teacher (Ilker, 2014). Feedback provides parents, teachers, and the students themselves with reports and records of what the students are doing, whether they are doing well or they need improvement. Studies carried out by Ilker (2014) and Pekrum et al. (2014) found that feedback fosters mastery achievement goals and motivates continuity of efforts. In the light of the above literature, this study sought to find out whether GO or EL with feedback could be a suitable teaching strategy that may enhance students' critical thinking and achievement in the basic science and technology. To achieve the above objectives, the following research questions raised and hypotheses were formulated to guide the study.

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Research Questions

1. What are the mean critical thinking test (CTT) scores of basic science students before and after exposure to GO and EL with feedback teaching methods?
2. What are the mean achievement scores of students in basic science achievement test before and after exposure to GO and EL with feedback teaching methods?

Hypotheses

1. There is no significant difference between the mean scores of post-CTT of students exposed to GO and those exposed to EL with feedback
2. There is no significant difference between post basic science and technology achievement test mean scores of students exposed to GO and EL with feedback.

METHODOLOGY

The study employed a quasi-experimental design (Agogo and Achor, 2019). Specifically, the study employed a modified separate sample pre-test-post-test design in which the selected intact classes were randomly assigned to either Experimental I or Experimental II groups. This design has no control group, and randomization was not applied on getting the samples for the Experimental I and Experimental II groups. The Experimental I group was taught habitat and ecology using GO learning techniques while the Experimental II group was taught habitat and ecology using EL technique.

A sample of two junior secondary schools and 75 junior secondary school two students were drawn from a population of 22 public junior secondary schools and 1950 JSS2 students in Jos North Local Government Area of Plateau State of Nigeria, using the hat and draw method of simple random sampling technique. Since intact classes and their regular teachers were used, students' consent was sought on the grounds that their test results (i.e., pre-test and post-test) will be used for research purpose outside their school environment and will be published without their names. They were asked to write their names and sign permitting their teachers to give out their results without their names. Second, in addition to general poor performance on this topic (habitat and ecology) in Plateau State, the dearth of research reports indicating the use of the GOs and EL strategies in the study area justifies the choice of the location. The instruments used for data collection were basic science and technology achievement test (BSTAT) with 15 multiple choice items and CTT with four essay items were developed by the researchers. The instruments were validated by three experts, two from science education and one from measurement and evaluation field, from the Benue State University and University of Jos, respectively. The instruments were trial tested on a sample of 39 students and the reliability indices were 0.81 and 0.79, respectively, using item response theory three parameter logistic model. Lesson plans were used in administering the treatment to both Experimental I and Experimental II groups. The treatment lasted for 5 weeks while pre-test and post-test were administered before and after the end of the treatment to both Experimental I and Experimental II groups, respectively. The statistical tools used for data analysis were mean, and analysis of covariance (ANCOVA). The ANCOVA was used to help control for the effect of differences in pre-test before the treatment as result of non-randomization of the groups.

RESULTS

Research Question 1

What are the mean CTTs scores of basic science students' before and after exposure to GO and EL with feedback teaching methods?

Table 1 and Figure 1 show that students taught using GO (Experimental group I) had a mean gain of 13.02 while students taught using EL (Experimental group II) had a mean gain of 12.01 in the CTT, respectively. This indicates that the Experimental Group 1 students taught using GO teaching strategy developed higher critical thinking than the Experimental Group II taught using EL strategy. Figure 1 shows clearly that the difference between the mean gains of the two groups is only 0.01 in favor GO group.

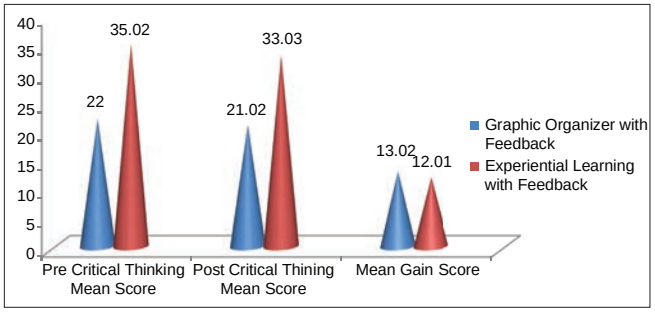

Figure 1: Mean Pretest, Posttest and Gain in Critical Thinking Scores for Graphic Organizer and Experiential Learning with Feedback

Table 1: Mean and standard deviation of pre-critical thinking and post-CTTs mean scores of JSS II Students taught using graphic organizer and experiential learning with feedback

Group	Number of students	Types of Test				Mean diff.
		Pre-test		Post-test		
		X	SD	X	SD	X
Experimental I (graphic organizer with feedback)	39	22.00	4.69	35.02	5.92	13.02
Experimental II (experiential learning wit feedback)	36	21.02	4.58	33.03	5.76	12.01

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Table 2: Mean and standard deviation of pre- and post-basic science achievement test mean scores of JSSII students taught using graphic organizer and experiential learning with feedback

Group	Number of students	Types of test				Mean diff.
		Pre-test		Post-test		
		X	SD	X	SD	X
Experimental I (graphic organizer with feedback)	39	21.03	4.60	34.02	5.83	12.99
Experimental II (experiential learning with feedback)	36	20.02	4.58	32.04	5.65	12.02

Research Question 2

What are the mean achievement scores of students in basic science achievement test before and after exposure to GO and EL with feedback teaching methods?

Table 2 and Figure 2 reveal that students taught using GO (Experimental I) had a mean gain of 12.99 while students taught using EL (Experimental II) had a mean gain of 12.02 in the BSTAT, respectively. This indicates that the Experimental Group I students taught using GO teaching strategy performed better than the Experiential Group II students taught using EL strategy. From Figure 2, it is clear that the mean gain difference between the two groups is very small (0.97) in favor of GO group.

Hypothesis 1: There is no significant difference between the mean scores of post-CTT of students exposed to GO and those exposed to EL with feedback.

ANCOVA was conducted to determine if a significant difference existed in the post-CTT achievement mean score of Experimental I and Experimental II groups after pre-test effect was controlled. Table 3 reveals that GO teaching with feedback was not significantly different with EL with feedback effect on students critical thinking mean in CTT after controlling for the effect of critical thinking achievement scores, $F(3, 81) = 2.236$, $\rho > 0.05$. The null hypothesis is therefore not rejected. This implies that there is no significant difference between the post-test mean scores of the Experimental I and the Experimental II groups.

Hypothesis 2: There is no significant difference between the post-test basic science and technology achievement mean scores of students exposed to GO and those exposed to EL with feedback.

The ANCOVA was conducted to determine if a significant difference existed in the post-test BSTAT achievement mean score of Experimental I and Experimental II groups after pre-test effect was controlled. Table 4 shows that the effect of GO teaching strategy was not significantly different from EL with feedback. The effect on students achievement mean score in BSTAT after controlling for the effect of pre-test BSTAT achievement score is $F(1, 58) = 1.282$, $\rho > 0.05$. The null hypothesis is therefore not rejected. This means that there is no significant difference between the post-test mean scores of the Experimental I and the Experimental II groups in the BSTAT. It implies that both methods enhanced students' achievement.

Table 3: Summary of ANCOVA result of the difference in post-critical thinking test mean scores of Experiential I and Experiential II group students

Source	Type III SS	df	Mean square	F	Sig
Corrected model	452.248	2	226.124	1.325	0.272
Intercept	4389.632	1	4389.632	25.712	0.000
Pre-post-CTT score	3.643	1	3.643	0.021	0.884
Group	381.821	1	381.821	2.236	0.139
Error	12292.099	72	170.724		
Total	93958.000	75			
Corrected total	12744.347	74			

R squared=0.035 (adjusted r squared=0.009)

Table 4: Summary of ANCOVA result of difference in post-test BSTAT achievement mean scores of Experimental I and Experimental II groups

Source	Type III SS	df	Mean square	F	Sig
Corrected model	852.369	2	426.185	3.455	0.037
Intercept	8352.604	1	8352.604	676.709	0.000
Pre-test BSTAT score	682.687	1	682.687	5.534	0.021
Group	158.142	1	58.687	1.282	0.261
Error	8881.977	72	123.361		
Total	88596.000	75			
Corrected total	9734.347	74			

R squared=0.088 (adjusted r squared=0.062)

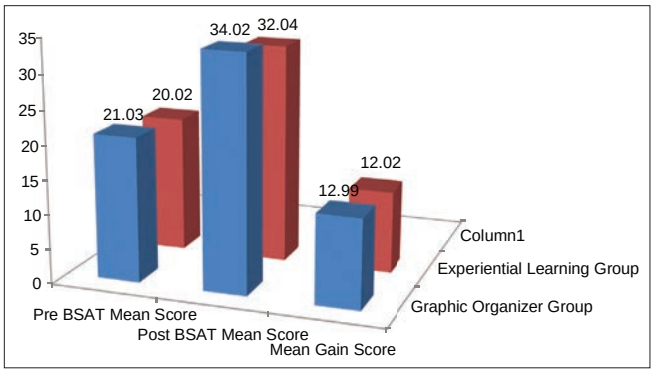

Figure 2: Mean Pretest, Posttest and Gain in Achievement Scores for Graphic Organizer and Experiential Learning with Feedback

DISCUSSION

The results of the study revealed very glaringly that both experimental methods have great potentials in fostering the development of critical thinking as well as promoting

meaningful learning in students. The active involvement of students in the teaching/learning activities and their ability to think out and draw on relevant experiences could have helped in building up their cognitive frame and stimulating the development of their reasoning ability. Abonyi and Okoli (2014), linked EL to constructivist approach of teaching, suggesting that the strategy motivated students and aroused their interest in learning, especially as they had to draw from first-hand experience to construct their knowledge. Students' active involvement in knowledge construct improves students' thinking ability and, at the same time, builds a formidable conceptual repertoire that will always lead to meaningful learning. However, the use of GO strategy turns out to be more effective in improving students' critical thinking in basic science and technology than EL strategy. The greater proficiency of GO strategy over EL can further be explained in terms of the fact that GOs has to do with spatial representation of concepts. This spatial arrangement gives room for the identification of missing information, or absent connections in ones thinking which invariably will promote critical analysis to arrive at appropriate solutions. According to Delarose (2011), GOs facilitate higher complexity of activities in learners especially using feedback. In the views of Clark (2007), GO improves critical thinking as the students do not only record and categorize information, but to help them understand difficult concepts, generate thoughts, and identify connections between ideas. This finding is in line with the view of Zaini et al. (2010) and Kansizoglu (2017) that GO helps students organize their learning in a spatial arrangement, by relating concepts with other concepts. Through this process, the critical thinking abilities of the students were enhanced. This position is supported by the views of Kumar and Rizwaan (2013) and Sharma (2012) who in their respective researches, asserted that graphic organization is highly effective instruction for developing critical thinking skills which can be used for other meaningful learning activities in all subject areas.

The result further revealed that students taught using GO strategy performed better in the BSTAT than students taught using EL though the difference was not statistically significant. This study indicates that Experimental Group 1 students taught using GO did not only develop higher thinking ability than Experimental II taught using EL but also demonstrated a better grasp of the concepts. GO strategy provides a visual method of developing, organizing, and summarizing students learning that helps to structure information thereby leading to meaningful learning. Although GO provides a framework for the development of ideas and constructing knowledge (Drapeau, 2010), both strategies were used in this study with adequate feedback, which explains partially why the difference is not statistically significant. The feedback helped to promote dialogue and conversation as well as engaging and tasking the students, thereby keeping them mentally focused. According to Hattie (2012) and Nicol (2010), feedback is an important part of the learning cycle, with additional benefits of encouraging students' metacognition and making the students more active. Furthermore, the insignificant difference could be explained from the point that both strategies are student oriented, demand for active participation of the learners and provide opportunity for learners to have something to key in their understanding and remembrance. In addition, both strategies allowed students to be independent learners, enhance collaboration and makes learning relatable to students. The learning atmosphere created by both strategies no doubt would have promoted comprehension which translated into high achievement. This study agrees with McElroy and Coughlin (2009) that GO help students to store information in student's brain in an organized and meaningful manner. This study agreed with the study conducted by Oliver (2009) which reveals that GO help in students to learn meaningfully. The study also revealed that GO increased students' achievement in basic science. The study disagreed with the study conducted by Wurdinger and Carlson (2010)**.** Which revealed that EL improved students' achievement and critical thinking. It should be noted however that the study by Calson (2010) did not compare experiential strategy with GO. This may have accounted for the disparity in finding.

CONCLUSION

The importance of GO and EL strategies cannot be overemphasized. Both GO and EL strategies enhanced students' achievement and critical thinking in basic and technology. However, the difference in their mean achievement and critical thinking scores was not statistically significant.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Basic science teachers should use GO strategy in the teaching and learning of ecology and habitat and other concepts in basic science since it has been found to improve achievement and critical thinking of students
2. Teachers should be encouraged by employers to go for seminars and workshops organized to promote the use of the new strategies
3. Teachers of basic science should employ the use of activities that promote high critical thinking
4. Teachers should employ the use of activity based strategy to help students achieve higher in basic science.

REFERENCES

Abonyi, O.S., & Okoli, J.N. (2014). Effect of experiential learning strategy on secondary school students' achievement in biology. *US China Education Review*, 4(2), 96-101.

Achor, E.E., & Agamber, S.T. (2016). Effect of frequent practical work on secondary school students' achievement in biology. *Journal of Science Technology Mathematics and Entrepreneurial Education,* 1(1), 14-24.

Achor, E.E., Odoh, C.O., & Abakpa, V.O. (2018). Use of investigative laboratory strategy in enhancing acquisition of science process skills among senior secondary biology students. *Journal of Research in Curriculum and Teaching*, 1(1), 103-109.

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. Available from: http://www.investigacion-psicopedagogica.org.

Agbo, F.O., & Taukek, E. (2011). *Enhancing Effective Teaching of Cellular Biology Through Science Technology and Society Approach*. Vol. 1. Plateau State: Science Teachers Association of Nigeria. pp. 59-68.

Agogo, P.O., & Achor, E.E. (2019). *Research Methods and Statistics for Beginners*. United States: Optimism Publication.

Akinmade, C.T.O. (2011). *Effective Teaching of STM Subjects in Secondary Schools*. Vol. 1. Plateau State: Science Teachers Association of Nigeria. pp. 28-45.

Anyaegbunam, N.J. (2012). *Effects of Constructive Theatre Instruction on Students' Knowledge of HIV, AIDS and Sexual Behave or in Enugu State of Nigeria*. Nsukka: University of Nigeria.

Basic Education Certificate Examination. (2012-2016). *Benue State Examination Board.* United States: State Government Press.

Clark, A. (2007). *Graphic Organizers and the School Library Programme*. Canada: University of Alberta, Department of Elementary Education.

Dauda, M. (2014). *Teachers' Knowledge and Application of Innovative Strategies in Teaching Basic Science*. Vol. 2. Plateau State: Science Teachers Association of Nigeria. pp. 169-179.

Delarose, L. (2011). *Investigating the Use of Graphic Organizer for Writing*. Louisiana: Louisiana State University.

Drapeau. E.E. (2010). Using graphic organizers to teach vocabulary: Does available research inform Science instruction? *Educational Journal*, 11(8), 538-540.

FME. (2012). *Nigerian Educational Research and Development Council (NERDC). Junior Secondary Education Curriculum for Basic Science and Technology*. Lagos: NERDC Press. pp. 1-3.

FRN. (2014). *National Policy on Education.* Nigeria: FGN Press.

Hattie, C. (2012). The power of feedback. *Review of Educational Research*, 77, 81-112.

Ilker, G.E. (2014). Effects of feedback on achievement goal, and perceived, motivational climate in physical education. *Issues in Educational Research*, 24(2), 153-161.

Kansizoglu, H.B. (2017). The effect of graphic organisers on language teaching and learning areas: A meta-analysis. *Education Science*, 42(191), 139-164.

Kumar, M., & Rizwaan, M. (2013). Impact of teaching through concept mapping on achievements in social studies component. *International Index and Referred Journal*, 4(6), 54-57.

Lakpini, A.M., & Atedoga, M.M. (2013). Effects of science technology and society instructional strategy on academic achievement in biology among slow learners in selected secondary schools in Giwa inspectorate, Kaduna, State Nigeria. *International Journal of Research in Science Technology and Mathematics Education*, 5(32), 81-123.

Mankilik, M. (2014). *Innovation in Science Technology and Mathematics*. Vol. 2. Plateau State: Science Teachers Association of Nigeria. pp. 1-8.

Mbanefo, M.C. (2016). Effective application of facilitation techniques approach for promoting creativity in basic science students. *Proceedings of the 57th Annual Conference of Science Teachers Association of Nigeria*. Kwali, Abuja: Streaming Media Company.

Mbenefo, M.C. (2015). Developing Creative Thinking Skills in Basic Science. *Teachers Association of Nigeria,* 50(10), 207-216.

McElroy, L.T., & Coughlin, C.N. (2009). *The Other Side of the Study: Using Graphic Organizers as Cognitive Learning Tools to Teach Students to Constructive Counter-analysis*. Maryland: University of Baltimore Law Review.

Nicol, D. (2010). Good design for feedback with students. In: Svinicki, M., & Mckeachie, W.J. (Eds.), *Mckeachie's Teaching Tips. Strategies, Research and Theory for College and University Teachers*. United States: Wadsworth Cengage Leaning. pp. 108-240.

Northern Illinois University. (2011). Faculty development and instructional design centre of science test. *Journal of Science Educational Technology*, 18, 402-414.

Pantzaira, M., Gagatsis, A., & Elia, I. (2009). Using the diagram as tools for solution of non-routine mathematics problems educational study math. *Education Studies in Mathematics*, 72(1), 39-60.

Pekrum, R., Cusack, A., Murayama, K., Elliot, A.J., & Thomas, K. (2014). The power of anticipated feedback: Effect on students' achievement goals and achievement emotions. *Learning and Instruction*, 29, 115-124.

Plateau State Ministry of Education. (2017). *Basic Education Certificate Examination* (*BECE*), 2012-2016. Plateau State Nigeria: Research and Statistic Office, Ministry of Education.

Samba, R.M.O. (2010). Trends in the development of science mathematics education in Nigeria since independence and the vision 20:20:20. In: *Lead Paper Presented at the 6th National Conference School of Sciences*. Ankpa: Kogi State College of Education.

Samba, R.M.O., Achor, E.E., & Ogbeba, J.A. (2010). Teachers awareness and utilization of innovative teaching strategies in secondary school science in Benue State Nigeria. *Educational Research*, 1(2), 32-38.

Sani, I.D., & Nsorfo, C.C. (2013). Effects of reciprocal peer tutoring on the academic achievement of students integrated science. *International Journal of Research in Science Technology and Mathematics Education*, 1(2), 15-23.

Sharma, J. (2012). Effects of concept mapping strategy on the learning outcome in relation to intelligence and study habits. *International Multi-Disciplinary E-Journal Experience*, 54, 194-199.

Wurdinger, S.D., & Carlson, J.A. (2010). *Teaching for Experiential Learning*: *Five Approaches that Work*. Lanham: Rowman & Littlefield Education.

Zaini, S.H., Moktar, S.Z., & Nawawi, M. (2010). The effect of graphic organizer on students' learning in school. *Malaysian Journal of Educational Technology*, 10(1), 17-23.