



Effectiveness of Brain-based Teaching Strategy on Students' Achievement and Score Levels in Heat Energy

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Abstract: Physics is an important subject taught at the secondary level in Nigeria but the achievement of students in the subject is a concern to science educators. This study investigated the effectiveness of brain-based teaching strategy (BTS) on students' achievement and score levels on the concept of heat energy. This investigation adopted the pretest, posttest, randomized control group quasi-experimental design. Simple random sampling technique was used to select two schools used for this study. Two research questions were raised to guide the study. Likewise, two null hypotheses were tested for acceptance or otherwise at 0.05 significance level. The sample involved ninety nine senior school students randomly selected from two schools in Ondo, Nigeria. Two instruments were used to gather data with internal consistency of 0.74 using Kuder Richardson Formular 21. The data collected were analysed using mean, t-test and Analysis of Covariance (ANCOVA). Findings from this investigation reveals that brain-based teaching strategy has significant effect on physics students' achievement and score levels in the concept of heat energy. This study concludes that brain-based teaching strategy should be used to teach heat energy at secondary school level in order to better students' grades.

Keywords: achievement; brain-based teaching strategy; heat energy; physics; score levels

Recommended citation: Bada, A. A. (2022). Effectiveness of Brain-based Teaching Strategy on Students' Achievement and Score Levels in Heat Energy. *Journal of Innovation in Educational and Cultural Research*, 3(1), 20-29.

INTRODUCTION

Physics is no doubt one of the major sciences taught at the senior secondary level in Nigeria. Its importance to nation building has been stressed at different areas (Omosewo, 2009; Erinosh, 2013). Bada and Akinbobola (2017) opined that physics is one of the basic science subject required for the development of any nation. Physics as a branch of science deals with energy and matter and their connection (Omosewo, 2009). This connection between energy and matter has resulted in the discovery of great devices which have no doubt made life easier for man to live. Physics can be said to cushion the effect of living in a relatively troubled environment. The study of Physics have also made the development of satellites and space ships which was once difficult, easy. The senior secondary school physics curriculum advocates for basic literacy of physics for functional living, acquisition of basic concepts and principles as prerequisite knowledge for further studies (FGN, 2013). This would be possible if students appreciate the physics concepts taught at the senior secondary schools.

The Nigerian senior secondary school physics curriculum is developed under six themes namely; Interaction of matter, space and time; Conservation principles; Waves- Motion without material transfer; Fields at rest and in motion; Energy quantization and duality of matter; and Physics in technology. Heat energy is a concept discussed under theme two and students have shown a level of difficulty in the topic (Bada, et al., 2018). This result might be responsible for the relative poor performance experienced by students in the subject.

Table 1. Candidates Enrolment and Performance in West African Examinations Council May/June Examination in Physics

Year	Total Numbers of Students Who Registered	Total Credit Passed (A1-C6)	% Credit Passed (A1-C6)	Total Below Last Credit (D7-F9)	% Below Last Credit (D7-F9)
2012	624658	429415	68.74	195243	31.26
2013	637023	297988	46.77	339035	53.23
2014	635729	386270	60.76	249459	39.24
2015	657850	391114	59.45	266736	40.55
2016	666830	508367	76.23	158463	23.77
2017	377854	205757	54.45	172094	45.55
2018	728354	571687	78.49	156667	21.51
2019	725853	565746	77.94	160107	22.06

Source: Statistics Section West African Examination Council Yaba Lagos 2019

Table 1 shows the relative poor performance of students in physics in the West African Examinations between 2012 and 2019. Physics students' performance in external examination in senior Secondary Schools in Nigeria is still not yet hundred percent. A review of the last eight years results of the West African Examinations Council (WAEC) shows that physics students' performance though good but not yet hundred percent. Researchers, especially Physics educators are concerned about this situation and have found out several factors that could be responsible for this relative poor performance. Some of these researches attributed the factors to include poor attitude, poor motivation, poorly sourced teaching and learning environment, non-coverage of physics topics or syllabus, relative difficulty experienced by practicing physics teachers in some topics and poor teaching methods (Harry, 2011; Erinosho, 2013; Akinbobola & Bada, 2018; Bada, et al., 2018).

Out of all these identified factors, the teachers teaching method plays a vital role. This is because the physics teacher is the chief implementer of the curriculum and he is responsible for ditching out the curriculum contents in bits to the students. One of the modern teaching strategy which has the capacity to better senior secondary school students' achievement in physics in brain based teaching strategy. Scholars such as Morris (2010), Saleh (2011; 2012), McNamee (2011), Kiedinger (2011); and Aravind and Binulal (2013) have worked on the effects of brain-based method on elementary teachers, Physics students, reading achievements, understanding of Newtonian Physics among form four students and attainment and retention of information respectively and found it to have significant effect on students' performance. This investigation is considered important because the use of brain-based teaching strategy might assist in improving senior secondary school students' achievement and score levels in heat energy.

Brain-based teaching strategy is one of the recent and modern strategy that can be used to improve students' grades. Jesen (2008) explained brain-based education as the engagement of methods based on standards got from the comprehension as given by neuroscience. Science educators now use methods they feel will viably reach all students individual needs irrespective of their background. Students must now use their knowledge of the brain and how the brain learns to decide upon strategies they consider brain-based and how it affects learning. The guidelines of brain-based learning show that effective learning can happen only through rehearsing real life experiences. Brain-based teaching is closely associated with constructivist learning theory. According to Ozden and Gultekin (2008), brain-based classroom are called brain – friendly places. These classrooms are the learning areas where the brain's function and their roles in learning are considered in terms of teaching and learning process. Brain-based teaching deals with the engagement of techniques in view of how the brain works (Caine & Caine, 2003). The brain is a fundamental piece of the human body that controls and arranges some of the body framework such as breath, feeling learning.

This study adopted the theory of Caine and Caine (2003); and Sousa (2011). The theories recommend a few standards to be considered by the teacher while applying brain-based teaching technique. This include:

- i. The brain is a complex versatile framework;
- ii. The brain is a social brain;
- iii. The scan for meaning is innate;
- iv. Emotions are basic to discovering importance of data;
- v. Learning includes no less than two methods for organizing memory- spartial and rote;
- vi. Learning is formative;

- vii. Complex learning can be upgraded by challenges and restrained by risk; and
- viii. Every brain is interestingly sorted out.

The theory of [Caine and Caine](#) (2003) also prescribed three critical strategies to carry out the method of brain-based teaching strategy. These include orchestrated immersion, relaxed alertness and action learning. Orchestrated immersion deals with making a learning domain that encompasses the students with intriguing and related hand-on exercises. Relaxed alertness has to do with removing fear while making a challenging learning condition and action learning includes interfacing information to earlier learning and enabling the students to effectively process the information. For this study, the researcher adopted the relaxed alertness mode for intervention during this investigation. Students are taught content learnt in bits and are allowed to rest in between.

New Physics instruction would be introduced amid 'prime-time 1' and conclusion on the theme in 'prime-time 2'. This is on the account that students recall the information that comes first (prime-time 1), they recollect second best information that comes last (prime-time 2), and they likewise recall minimum the information that comes in the middle (down time) ([Sousa, 2011](#)). Physics instruction would be structured into a few 20-40 minutes fragment. Prime-time 1, will occur for approximately 10-15 minutes, downtime, 2 minutes and 'prime-time 2, 3 minutes. The Physics teacher would likewise make utilization of the accompanying methodologies during intervention in the classroom. First is movement, the teacher would allow students to move up and down in the wake of sitting for twenty minutes. This is to permit blood and basic oxygen reach the brain on the grounds that the brain depends on such a great amount on it to reenergize accordingly and amplify learning. Participating in work out, eating of natural fruits, drinking of water and chewing of gum has demonstrated to fortify the brain action and blood stream in this way, having the likelihood of enhancing students' scholarly performance in Physics. Second is brain fuel, the teacher presents things that would help renew the brain fuel since the brain liquid must have been used up during challenging task (instructing learning process). The teacher would present things that help support working memory, focus and motor function by expanding the level of glucose, oxygen and water in the brain and the third intervention used is humour. The physics teacher would begin the class with a high comical inclination that makes ease in the classroom. This would help in creating positive feelings henceforth, improving retention. Retention in physics is additionally accomplished when information is associated with past experience henceforth, the need to empower hand-on exercises.

Score levels also known as ability levels refers to the different achievement levels of physics students in a particular task that can be graded. Achievement refers to students' success in meeting short or long term goals. Achievement also refers to the accomplishment of a given task measured against preset known standards of accuracy, completeness, cost and speed. Score levels have been discovered to influence students' performance in physics when taught using developed instructional package ([Afolabi & Akinbobola, 2009](#); [Omiola, et al., 2012](#)). Students score levels can therefore be grouped under three heading namely high scorers, average scorers and low scorers. He opined that students achievement or performance often follow the principle of individual difference as they show variation in individuals ability such as high, average and low achievers.

A review of the literature reveals that brain based teaching program has positive effects on students' achievement in science. [Altiti](#) (2014) investigated the impact of brain based teaching program on the achievement of 5th grade students in science and found out that students exposed to brain based teaching program performed better when compared to those students who were not exposed to the program. [Saleh](#) (2011) studied the effectiveness of brain based teaching approach on physics students' motivation to learning. He adopted the quantitative approach in analyzing issues related to students' motivation to learn physics. The results from his investigation revealed that brain based teaching was an effective teaching approach because physics students taught using brain based learning approach were better motivated to learning physics when compared to their counterparts who received teaching using the conventional teaching method.

Again [Saleh](#) (2012) investigated the effectiveness of brain based teaching approach on students' understanding and comprehension of physics. His study involved 100 secondary school students taught Newton laws and the findings from his investigation revealed that students taught physics using brain based teaching approach were able to understand and comprehend Newtons laws. [Saleh and Mazlan](#) (2019) studied the effects of brain based teaching with i-Think maps and brain gym approach on physics students' conceptual understanding of force and motion. They employed a quasi-experimental design involving 180 college students in Malaysia. [Saleh and Mazlan](#) (2019) taught the experimental group force and motion using brain based teaching with i-think maps and brain gym approach while the control group was taught the same content using the conventional method. The researchers adopted brain based teaching which focused on

optimum function of the brain, skill thinking promotion and enhancement, relaxed and fun learning environment. The result showed that brain based teaching with i-think map and brain gym approach improved students understanding of physics irrespective of students' gender.

In Nigeria, Jack, et al. (2018) investigated the effect of brain based teaching model on the achievement of 100 level physics students in colleges of education in Taraba state. They adopted the quasi experimental design involving 66 students. The experimental group was taught current electricity using brain based learning model while the control group was taught the same content using conventional teaching method. The researchers employed the three instructional teaching techniques of relaxed alertness, orchestrated immersion and active processing on the experimental group. The results from their study revealed that students taught current electricity using brain based learning model achieved better than their counterparts taught the same content using conventional teaching method. The researcher also found out that students taught using brain based learning model were able to retain the concept learnt better than those taught using conventional method.

The reviewed literature showed the efficacy of brain based teaching method on teaching outcomes in the form of achievements and performance on different curricula (physics, mathematics) and on different levels of education (primary, secondary, tertiary) (Saleh, 2011; 2012; Altiti, 2014; Jack, et al., 2018; Saleh & Mazlan, 2019). Literature also revealed that most investigations on the effectiveness of brain based teaching strategy in physics were carried out by foreign researchers (Saleh, 2011; 2012; Altiti, 2014; Saleh & Mazlan, 2019) with only few studies carried out in Nigeria on the effectiveness of brain based teaching strategy on students' achievement and score levels (Jack, et al., 2018). The study that was carried out in Nigeria was even done to investigate the effectiveness of brain based teaching strategy on colleges of education physics students and not on senior secondary school students.

This investigation therefore provides an empirical evidence of the effectiveness of blended learning teaching strategy on senior secondary school students' achievements in heat energy. This study has two objectives: (i) to determine the effect of brain based teaching strategy on students' achievement in heat energy; (ii) to determine the influence of score levels on students' achievement on heat energy when taught using brain based teaching method. In line with the objectives, two research questions were raised to guide the investigation: (i) what is the effect of brain-based on senior secondary school students' achievement in heat energy? (ii) what is the influence of score levels on students' achievement in heat energy when taught using brain-based teaching strategy? For the purpose of making a general statements on the effectiveness of brain based on senior secondary school students' achievements in heat energy, two null hypothesis (i) there is no significant difference in the achievement of senior secondary school students' taught Heat energy using brain-based teaching strategy and those taught using conventional teaching strategy, (ii) there is no significant influence among the achievement of low, average and high scorers when taught Heat energy using brain-based teaching strategy, were tested for acceptance or otherwise at a significance level of 0.05.

METHODS

The study was a quasi-experimental research of the design, pre-test, post-test, non equivalent, randomized control group. Quasi- experimental design is a design that is specifically useful for answering scientific questions (Fokides & Papoutsis, 2020) hence it was considered appropriate for this investigation. Quasi-experimental design was adopted for this investigation because it measures cause and effect with at least one independent variable manipulated but participants are not randomly assigned to groups.

Participants

Two schools were selected from the senior secondary schools in Ondo, Nigeria using simple random sampling technique. Mistra and Alok (2011) opined that simple random technique gives equal chance from selecting the population. Only two senior secondary schools were involved in the study out of a total number of twenty three senior secondary schools in Ondo. The sample used for the study comprised two intact senior secondary school physics classes from the two schools used in Ondo, Nigeria. The experimental group comprised of forty six students while the control group comprised of fifty three students. The experimental group was taught the Heat energy using brain-based teaching strategy while the control group was taught the same physics content using conventional teaching strategy.

Instrument

Two instruments were used to obtain data for the study. They are; Lesson Instructional Package (LIP) using brain-based teaching strategy and conventional teaching strategy respectively on the concept of heat energy; and Physics Achievement Test on Heat Energy (PATHE). The lesson instructional package was carefully designed on the concept of heat energy based on the principles and designs of brain-based teaching strategy while the conventional teaching strategy was also designed using the normal way of having lessons. Physics Achievement Test on Heat Energy (PATHE) consist of fifty multiple choice items constructed on the concept of Heat energy with each of the items having four options lettered A to D. The options have one correct answer with three distractors; PATHE was used to determine the achievement of students on the content of heat energy. Physics students were divided into three score levels (high, average, low) based on the scores obtained from the pre-test administration of PATHE. Physics students whose scores fell below lower quartile (Q1) were classified as low scorers, physics students whose scores fell above upper quartile (Q3) were classified as high scorers while physics students whose scores fell between lower quartile (Q1) and upper quartile (Q3) were classified as average scorers. The two instruments; LIP and PATHE, used for this study were validated by two experienced Science Education experts from the University and two experienced Senior Secondary School Physics teachers. PATHE was also validated using the test blue print as designed by Bloom. The validated items were subjected to item analysis which showed that the average difficulty index and discriminating power read 59.6% and 51.0% respectively. The reliability of PATHE was achieved by administering the test items to senior secondary school students in a non-participating school. A reliably coefficient of 0.76 was obtained through Kuder Richardson's formular 21.

Data Analysis

After I obtained permission from the principals of the schools concern and the consent of the students had been sought, the students in the experimental group were taught heat energy using brain-based teaching strategy by me using the carefully designed lesson instructional package using brain-based teaching strategy while the control group was taught the same content by the me using the lesson instructional package on conventional teaching strategy in their different schools and at different times in other to avoid interference. The teaching lasted for four weeks based on the scheme of work on heat energy as replicated in the Nigerian senior secondary school physics curriculum but the experiment lasted for a period of nine weeks. The senior secondary school physics students were pre-tested before treatment and were also post-tested after completing the treatment. The data in form of scores collected from the experimental and control groups were analysed using mean, t-test and analysis of covariance (ANCOVA).

RESULTS AND DISCUSSION

Table 2. Demographic Representation of Participants According to Groups

Groups	N	%
Brain-based teaching strategy (BTS)	46	46.5
Conventional teaching strategy (CG)	53	53.5
Total	99	100.00

Table 2 shows the demographic representation of participants according to the two groups (Brain-based and Conventional teaching strategies). **Table 2** reveals that 46.5% of the participants were taught Physics using Brain-based teaching strategy while 53.5% of the participants were taught Physics using the Conventional teaching strategy.

Table 3. Demographic Distribution of Participants According to Score Levels

Score Levels	Brain-based (N)	Teaching Strategy (%)	Conventional (N)	Teaching Strategy (%)
Low	11	23.91	17	32.10
Average	21	45.65	28	52.83
High	14	30.44	08	15.07
Total	46	100.00	53	100.00

Table 3 reveals the demographic distribution of participants according to score levels (High, average, low). Table 3 shows that 23.91% and 32.10% were grouped as low scorers when taught using brain-based teaching strategy and conventional teaching strategy respectively. 45.65% and 52.83% of participants were grouped as average scorers when taught Physics using brain-based teaching strategy and conventional teaching strategy respectively while 30.44% and 15.07% of participants were group as high scorers when taught Physics using brain-based teaching strategy and conventional teaching strategy respectively.

Research Question 1: What is the effect of brain-based teaching strategy on senior secondary school students' achievement in heat energy?

Table 4. Students' Achievement in Heat Energy When Taught Using Brain-based Teaching Strategy and Control Group

Group	Group Statistic	Pretest	Posttest	Mean Gain Score	Difference
Brain Based	N	46	46		
	Mean	25.87	59.48	33.61	
	SD	9.59	10.35		
					7.35
Control	N	53	53		
	Mean	24.42	50.68	26.26	
	SD	9.51	9.93		

Table 4 shows the achievement of students who participated in the Physics Achievement Test (PAT). The mean gain score of students' taught heat energy using brain-based teaching strategy was 33.61 while the mean gain score of students' in the control group was 26.26. The mean gain score of students' taught heat energy using brain-based teaching strategy was 7.35 higher than the mean gain score of students in the control group.

Research Hypothesis 1: There is no significant difference in the achievement of senior secondary school students' taught Heat energy using brain-based teaching strategy and those taught using conventional teaching strategy.

Table 5. t-test Analysis of the Effect of Brain-based Teaching Strategy on Students' Achievement in Physics

Groups	N	Mean	Std.	Df	T	Sig.	Remark
EG	46	59.48	2.05	97	4.31	.00	*S
CG	53	50.68	1.46				

$P < 0.05$ Where: EG = Experimental Group CG = Control Group

Table 5 shows an independent sample t-test conducted to compare the achievement of students taught heat energy using brain-based teaching strategy and those students' taught heat energy using conventional teaching strategy. Table 5 revealed that the calculated t-value is 4.31 at 97 degree of freedom computed at 0.05 level of significance. Since the calculated level of significance 0.00 is less than the level of significance 0.05, ($p < 0.05$), hypothesis one is hereby not accepted. Hence, there is a significant difference between the performance of senior secondary school students' taught heat energy using brain-based teaching strategy and those taught heat energy using conventional teaching strategy. This means that students taught heat energy using brain-based teaching strategy achieved better than their counterparts taught using conventional teaching strategy.

Research Question 2: What is the influence of score levels on students' achievement in Heat energy when taught using brain-based teaching strategy?

Table 6. Achievement of Low, Average and High Scorers Taught Heat Energy Using Brain-based Teaching Strategy

Group	Group Statistic	Pre-test	Post-test	Mean Gain Score
Low	N	11	11	
	Mean	16.36	46.00	29.64
	SD	1.21	4.47	
Average	N	21	21	
	Mean	23.14	58.57	35.43
	SD	2.94	3.36	
High	N	14	14	
	Mean	37.43	71.43	34.00
	SD	8.47	5.40	

Table 6 shows the achievement of low, average and high score students taught heat energy using brain-based teaching strategy. The mean gain score of low, average and high scorers were 29.64, 35.43 and 34.00 respectively. The average scorers had the highest mean gain score followed by the high and low scorers respectively.

Research Hypothesis 2: There is no significant influence among the achievement of low, average and high scorers when taught Heat energy using brain-based teaching strategy.

Table 7. Achievement of Low, Average and High Scorers Taught Heat Energy Using Brain-based Teaching Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	sig.
Corrected Model	4593.048 ^a	3	1531.016	283.984	.00
Intercept	2138.403	1	2138.403	396.647	.00
Pretest	610.479	1	610.479	113.236	.00
BTS	313.354	2	156.677	29.06	.00
Error	226.430	42	5.39		
Total	167552.000	46			
Corrected Total	4819.478	45			

a. R Squared = .953 (Adjusted R Squared = .950)

Where: BTS = Brain-based Teaching Strategy

Table 7 reveals that the calculated f-value is 29.06 at 2 degree of freedom computed at 0.05 level of significance. Since the calculated level of significance 0.00 is less than the table value ($p < 0.05$), hypothesis two is hereby not accepted. This means that there is a significant influence among the achievement of low, average and high scorers taught heat energy using brain-based teaching strategy.

Table 8. Scheffe Post hoc Analysis on the Influence of Students' Score Level to their Achievement in Heat Energy When Taught Using Brain-based Teaching Strategy

Score Groups	N	Subset		
	1	2	3	
High	14	71.43		
Average	21	58.57		
Low	11		46.00	
Sig.		1.00	1.00	1.00

Scheffe Post hoc analysis was conducted to determine the direction of the significance among the low, average and high scorers in heat energy when taught using brain-based teaching strategy. Table 8 shows that the high scorers had a mean gain of 71.43, average scorers had a mean gain of 58.57 while the low scorers had a mean gain of 46.00. This revealed that the high scorers achieved best than the average and low scorers when taught heat energy using brain-based teaching strategy.

The result of the study showed that there was difference in the achievement of senior secondary school students taught heat energy using brain-based teaching strategy compared to their counterparts taught the same content using conventional teaching method. The mean gain scores of students were 33.61 and 26.25 for brain-based and conventional teaching strategies respectively. This finding also revealed that a mean gain difference of 7.35 existed between the two groups post-test scores after treatment (Brain-based, Conventional). This further confirms that brain-based teaching strategy had greater effect on the achievement of physics students taught heat energy than their counterparts taught the same content using the conventional teaching method

The result from hypothesis one confirms a significance difference between the achievements of physics students taught heat energy using brain-based teaching strategy and those taught using the conventional method. It can therefore be concluded that the use of brain-based teaching strategy will enhance students' achievement in the concept of heat energy better than the use of conventional teaching method. This finding is in agreement with McNamee (2011), and (Saleh 2011, 2012, Altiti, 2014; Jack, et al., 2018; Saleh & Mazlan, 2019) who found significant difference in favour of the students taught physics using brain-based teaching strategy.

The results from this investigation revealed that score levels have influence on students' achievement in heat energy when taught using brain-based teaching strategy. The findings showed that the mean gain scores of low, average and high scores differs with each of them having 29.64, 35.43 and 34.00 as mean gain scores respectively. This confirms that students score levels has influence on the achievement of physics students in heat energy.

As a way of finding out if this influence of score levels on students achievement, when taught heat energy using brain-based is significant, an f-value of 29.06 obtained at a significant level of 0.00 confirmed significant influence on students' score levels when taught heat energy using brain-based teaching strategy. The results showed that there is significant influence among the achievement of low, average and high scorers taught heat energy using brain-based teaching strategy because he mean gain score of low, average and high scorers were 29.64, 35.43 and 34.00 respectively. The average scorers had the highest mean gain followed by high and low scorers respectively. This finding agrees with Afolabi and Akinbobola (2009) and Omiola, et al. (2012) who found out that significant difference exist among the low, average and high scorers.

CONCLUSION

The study investigated the effectiveness of brain-based teaching strategy on students' achievement and score levels in the concept of heat energy in physics. The findings of this study showed that brain-based teaching strategy enhanced physics students' achievement in heat energy significantly. It can therefore be concluded that brain-based teaching strategy improved students' achievement in physics. Also, students' score levels in heat energy had significant influence on students' achievement in physics when taught using brain-based teaching strategy. It can therefore be concluded that on score levels (high, average, low), students differ in the manner they benefitted from the study with the average scorers benefitting most followed by the high and low scorers. The following recommendations were considered appropriate based on the findings from this study: (i) brain-based teaching strategy should be used to teach physics (heat energy) at the senior secondary school, (ii) seminars and workshops should be organized by professional bodies like Nigerian Institute of Physics (NIP), Science Teachers Association of Nigeria (STAN) and Nigerian Teachers' Institute (NTI) on how to use brain-based teaching strategy for effective teaching –learning process, (iii) in-service physics teachers should be taught on the use of brain-based teaching strategy through workshops organized by Ministries of Education both at the state and federal levels.

ACKNOWLEDGEMENT

I appreciate the cooperation of the management of the two senior secondary schools used for this investigation. I also appreciate Prof Esther O. Omosewo, for reading through the draft several time in order to put in in the best shape.

REFERENCES

- Afolabi, F., & Akinbobola, A. O. (2009). Constructivist problem based learning technique and the academic achievement of physics students with low ability level in Nigeria secondary schools. *Eurasian Journal of Physics and Chemistry Education*, 1(1), 45 – 51.
- Akinbobola, A. O., & Bada, A. A. (2018). Relative effectiveness of case-based and collaborative learning strategies on students' achievement and retention in Nigeria senior secondary school physics. *European Journal of Educational Studies*, 4(7), 49 – 62
- Altiti, M. (2014). The impact of a brain based teaching program on imploring the achievement of 5th grade students in sciences. *Journal of Islamic University*, 22(1), 111-138.
- Aravind, A., & Binulal, K. R. (2013). Review of related literature on brain based learning. *Indian Journal of Applied Research*, 3(7), 179-180.
- Bada, A. A., & Akinbobola, A. O. (2017). Effectiveness of experiential teaching strategy on students' achievement and scoring levels in senior secondary school physics. *European Journal of Education Studies*, 3(12), 552-564.
- Bada, A. A., Akinbobola, A. O., & Damoeroem, E. O. (2018). Measured identification and remediation of students' weakness in Nigerian senior secondary school Physics curriculum. *International Journal of Innovation Research and Advanced Studies*, 5(10), 13-19.
- Caine, R. N., & Caine, G. (2003). *Beyin temelli ogrenme*. (Interpreter Edt.: Gulden Ulgen). Ankara: Nobel Yayinlari.
- Erinosho, S. Y. (2013). How do students perceive the difficulty of physics in secondary schools: An exploratory study in Nigeria. *International Journal for Cross-Disciplinary Subjects in Education*, 3(3), 1510-1515.
- Fakayode, A. F. (2000). *Creativity-locus of control achievement, motivation and their relationship with the academic performance of senior secondary school science students*. [Unpublished doctoral thesis]. University of Ilorin, Ilorin.
- Federal Republic of Nigeria (FGN, 2013). *National policy on education*. Lagos: NERDC
- Fokides, J. E., & Papoutsis, A. (2020). Using Makey-Makey for teaching electricity to primary school students A pilot study," *Education and Information Technologies*, 25, 1193-1215,
- Harry, I. H. (2011). Attitude of students towards science and science education (A case study of selected secondary schools in river state). *Continental Journal of Educational Research*, 4(2), 33-51.
- Jack, U. G., Danjuma, G. S., & Gbademosi, B. O. (2018). Effects of brain based learning model on colleges of education students' retention and attitude in "current electricity" in taraba state, Nigeria. *Journal of Education, Society and Behavioural Science*, 25(2), 1-15.
- Jensen, E. (2008). *Brain-based learning: The new paradigm of teaching*. Thousand Oaks, CA: Corwin.
- Kiedinger, R. (2011). *Brain based learning and its effects on reading outcome in elementary aged students*. [Unpublished doctoral dissertation]. University of Wisconsin-Stout.
- McNamee, M. M. (2011). The impact of brain based instruction on reading achievement in a second grade classroom. [Unpublished doctoral dissertation]. Walden University. ERIC ED525320.
- Mishra, S. B., & Alock, S. (2011). *Handbook of research methodology: A compendium for scholars and researchers*. Educreation Publishing.
- Morris, L. T. (2010). *Brain based learning and classroom practice: A study investigating instructional methodologies of urban school teachers*. [Unpublished doctoral dissertation]. Arkansas University. ERIC ED514244.

- Omiola, M. A., Enuwa, M. R., Awoyemi, S. O., & Bada, A. A. (2012). Effect of developed video instructional package on the performance of senior secondary school physics students in Ilorin metropolis. *British Journal of Science*, 6(1), 45- 54.
- Omosowo, E. O. (2009). Views of physics teachers on the need to train and retrain physics teachers in Nigeria. *An International Multi-Disciplinary Journal*, 3(1), 313-324.
- Ozden, M., & Gultekin M. (2008). The Effects of Brain-Based Learning on Academic Achievement and Retention of Knowledge in Science Course. *Electronic Journal of Science Education*, 12(1), 2-17.
- Saleh, S. (2011). The effectiveness of the brain based teaching approach in generating students' learning motivation towards the subject of physics: A Quantitative Approach. *US-China Education Review A*, 63 -72.
- Saleh, S. (2012). The effectiveness of the brain based teaching approach in enhancing scientific understanding of Newtonian physics among form four students. *International Journal of Environment and Science Education*, 7(1), 107 – 122.
- Saleh, S., & Mazlan, A. (2019). The effects of brain based teaching with i-think maps and brain gym approach towards physics understanding. *Indonesia Journal of Science Education*, 8(1), 12-21.
- Sousa, D. A. (Ed.). (2011). *David A. Sousa's how the brain learns*. Thousand Oaks, CA: Corwin.