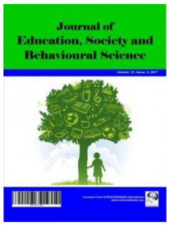

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Effect of Brain-based Learning Model on Colleges of Education Students' Retention and Attitude in "Current Electricity" in Taraba State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors JUG and GBO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author DGS managed the analyses of the study. Authors JUG and GBO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study investigated the effect of brain-based learning model on 100level physics students in colleges of education. Three research questions and two hypotheses were formulated. The entire population (intact classes) of 63 students was used, and it comprises of all the 100level physics students in the two colleges of education in Taraba State. A quasi-experimental design was employed and the experimental group was exposed to the treatment of brain-based learning model, while the control group was exposed to the conventional teaching method. Instruments used for data collection are the Current Electricity Achievement Test (CEAT) and a four-point attitude scale. The reliability of CEAT was estimated using the coefficient of internal consistency and the value of 0.90 was obtained. Research questions were answered using mean and standard deviation while hypotheses were tested using independent samples t-test analysis at 0.05level of significance. The result of this study showed that students taught with brain-based learning model acquired higher knowledge retention and positive attitude than their conventional teaching method

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counterpart. The result of findings, therefore, gives a recommendation that teachers should adopt the use of brain-based learning model in order to enhance students' achievement, knowledge retention and attitude.

Keywords: Brain-based learning model; students' achievement; knowledge retention and attitude; current electricity.

1. INTRODUCTION

Physics is mainly the study of motion and energy [1]. Traditionally, it consists of areas such as mechanics, electromagnetism, optics and thermodynamics. However, it has expanded to include quantum mechanics, relativity and nuclear physics.

Physics as one of the science subject taught at colleges of education offers the student an opportunity to think critically, reason analytically and to acquire the spirit of enquiry. For this reason according to Omosewo, Physics is an important discipline and a fundamental ingredient of technology [1]. This is in line with the view of Adeyemo, both developed and developing countries such as USA and Nigeria respectively have realized the importance of physics in national development [2]. Also, Jegede and Adebayo opined that National development in technology, basic concept and principles in physics are indispensable [3]. The teaching of physics in any college is to produce well motivated and qualified physics teachers that can reduce the dearth of teaching profession at every level of the educational system. It is so glaring that the attitude and knowledge retention of physics students in colleges of education in Nigeria has remained an issue of concern to all stakeholders. The importance of physics to technology development has earned it a place as a core and innovative subject for science students that want to teach it as a profession in future. Also, it is one of the major requirements for entry science and engineering programmes in higher institution in Nigeria.

Despite the importance of physics in the attainment of educational and technological development, it appears there is an increasingly low enrolment of physics students in colleges of education, it also appears that there is an increasingly few graduating students of physics in tertiary institutions [1,4]. This seems to be attributable to the poor achievement leading to poor knowledge retention and attitude of students at colleges of education and other tertiary institutions [1,4]. Consequently, the 60: 40 ratio of science to art admissions differential weighing, for colleges of education, are not being achieved over the years in Nigeria which can automatically result to compromising the scientific and technological future. This undesirable issue may be due to the difficulty of students' understanding the underlining concepts, due to the mere absence of an effective learning theory for impacting knowledge of physics concepts.

The knowledge and its retention in physics amongst students of colleges of education can shift coming generations from darkness to light if successful. It can also create a channel that leads to the attainment of a sustainable educational development and confirming the quality assurance according to National Commission for Colleges of Education (NCCE) policy. Knowledge retention plays an important role in sustaining educational and technological development in Nigeria, as well as, teaching the up-coming generations of physics students, aiming to be professional teachers. Effective teaching of students in colleges of education in Nigeria; helps in producing sound and qualitative physics teachers for growth and development in education. And with regards to higher education, National Policy on Education encourages the provision of qualified teachers at all levels of education. Section 8 subsection b, item 70b of the National Policy of Education; stimulated that the minimum qualification for entry into teaching profession shall be the Nigerian Certificate in Education (NCE) which led to the regular NCE programme offered by the college of education in the country [5].

In the attempt to enhance a sustainable educational development, most researchers focus on the cognitive sides of teaching and learning, but there is growing acceptance of the significance of the affective dimension of the issue. Affective factors mean a lot for how students respond to learning and their character in the long run. Though, according to Jack, many underlying reasons have advanced for the difficulty in sustaining students' positive attitudes in science (Physics inclusive); among other reasons are abstract nature of science, quantity and quality of science teachers, science teachers' attitudes and instructional techniques, dearth and absence of instructional facilities, high student-teacher ratio, nature of science textbooks and students' attitudes to science learning, including the learning of physics concepts [6]. Attitude is one major factor affecting the quality of learning. Attitudes can be associated with science (physics inclusive) and students' due to its abstract nature and misconception. When scientific attitudes are promoted in science classrooms, there will be an increase in students' attitudes toward science [6].

Attitude is an important determinant for teaching and learning of physics, and for the efficacy of student centered approach. Research evidence have shown that there exists a relationship between student's attitude and achievement, leading to long-lasting experience of knowledge retention [7-10]. Development of positive attitudes in students ensures effective learning that would be more meaningful and retentive [11]. This general relationship is based on the concept that the positive attitude a student has towards a subject or task, the higher the achievement or performance level tends to be [12]. Also, according to Weaver in Shiaki; it is 'attitude, not aptitude that determines altitude' and he commented that students with a positive optimistic attitude do better in college [13,14]. This also agrees with the National Policy on Education [15], which stresses that science education must be strengthened so as to develop in the learner some well-defined abilities and values like spirit of inquiry, creativity, objectivity, courage to question and aesthetic sensitivity. Rote learning approaches that are exam oriented and target easier topics, memorization, copying notes, teacher-centered instructional strategies, and inflexible instructions have been identified as factors that make it difficult to induce conceptual change and interest in science in students [12].

Most schools have resulted to the conventional method of teaching (teachers-centered) rather than student centered learning approach with teachers 'facilitation, moving from simple to complex or rather from known to unknown. This is in line with the view of Nwagbo and Ogbazi in Amuche and Iyekekpolor, whose research showed that physics teachers contribute to the poor quality of learning outcomes and; that students learn best if they are engaged in active learning during classroom instruction [16,17,4].

Classroom instruction is the art of developing the brain; hence, science instructors should learn how the brain functions and processes data to improve their teaching and enhance student performance using innovative, efficient and effective instructional strategies. However, in attempt to shift from the traditional or conventional method of teaching and to identify a suitable pedagogical strategy for teaching physics so as to enhance students' knowledge retention and attitude, many conceptual patterns and models (student–centered approach) such as guided inquiry, constructivism, problem solving among others have been advocated for yet they seem not be sufficient [18,19]. Therefore, this study intends to examine the efficacy of Brain-based learning strategy (student centered approach) on students' knowledge retention and attitude in 'current electricity' to ascertain if there will be an improvement in physics education.

Brain-based learning instructional strategy is a learner-centered and teacher-facilitated strategy that utilizes learners' cognitive endowments. The proponents of brain-based instructional strategy [20-23] identified three instructional learning techniques of the strategy: i) Relaxed Alertness (low threat and high challenge to bring the brain to optimal learning); ii) Orchestrated Immersion (tries to eliminate fear in learners, while maintaining a highly challenging environment) and; (iii) Active Processing (allows the learners to consolidate and internalize information by actively processing it). The Brain-Based Learning instructional strategy is also based on the Brain-Based Learning Principles, where detailed attention is given to seven main steps: (1) activation; (2) clarify the outcome and paint big picture of the lesson; (3) making connection; (4) doing the learning activity; (5) demonstrate student understanding; (6) review for student recall and retention/closure; and (7) preview the new topic [24].

The main objectives of brain research studies include teaching to individual differences, diversifying teaching strategies, and maximizing the brain's natural learning processes [25,26]. Therefore, understanding how the brain learns and relating it to the educational field resulted in the concept known as brain-based learning [27]. The brain functions in a way that it learns, assimilates, thinks and remembers in a threat-free environment. Lucas, Daniel and Nima, asserted that as long as the brain is not prohibited from fulfilling its normal processes, learning will occur since everyone is born with a brain that functions as immensely powerful problems [28]. It is an open sharing activity which encourages all students to participate through several learning strategies or activities; such as group discussion, peer teaching, self-assessment, group engaging assignment, hands-on lab, interactive lectures, co-operative learning and so on. According to Audrey, knowing how the brain works best allows educators to create an environment that gives the student a higher probability of success in learning [29].

Based on the findings of neuroscience according to Duman cited in Jack and Kyado, brain-based learning guides according to the principles and workings of the brain to improve the best way of learning, increase academic achievement, and provide equal opportunities for individual differences [30,27]. The brain performs better in a positive emotional state. Students must feel physically and emotionally safe before their brains are ready to learn. Teachers can create a positive environment by encouraging and praising their students' efforts. Processing time and reflection are also vital to the learning environment in order to enhance positive attitude and knowledge retention in learners. This was why Jesen cited in Jack & Kyado, opined that; no intelligence or ability will unfold until, or unless, it is given the appropriate model environment; which was adequately demonstrated in Brain-based learning [23,27]. Brain-based teaching approach was effective in enhancing students' scientific understanding of Newtonian Physics [24]. It was found that a majority of students from the group that followed the brain-based teaching approach possessed a better scientific understanding of Newtonian Physics compared to the group that received conventional teaching method. Unlike the traditional teaching methods, which is often said to inhibit learning by ignoring the brain's natural learning processes, the Brain-based teaching approach is believed to be more learner-friendly and boost learning due to its holistic approach towards the learners [7]. It is an approach to learning which favors the brain's best natural operational principles, with the goal of attaining maximum attention, understanding, meaning and memory [23].

More also, Saleh noted that students who followed the Brain-based teaching approach module possessed a better Physics learning motivation compared to students who received conventional teaching method [8]. Philip in Umoru declared that Brain-based increases students' achievement and provides equal opportunities for individual differences [31,19]. Brain-based learning, according to Jack & Kyado, which was implemented to experimental group, provided more retentive learning [27]. Contrarily, the works of Aydın, Yıldırım, Jack & Kyado, Getz and Samur, revealed that the Brain-based learning model neither had an influence on students' attitudes nor led to changes in their attitudes [9,10,27,32,33].

Brain-based learning model focuses on concepts that create an opportunity to maximize attainment and retention of information. Also, it can be applied to the learning process to understand the structure of the brain by considering the needs and styles of learners to evaluate and improve the course format and content delivery. However, according to Hutchins, brain based learning is still a questionable practice and further empirical research is warranted [34]. It is on this basis that the researcher is of investigational interest to use the three instructional learning techniques of the Brain-Based learning strategy by Duman and the seven Brain-Based Learning Principles by Caine et al. as the Brain-based learning model in this study [30,24].

1.1 Purposes of the Study

The purpose of this study is to investigate the effect of brain-based learning model on students' knowledge retention and attitude in current electricity. Specifically, the study has these objectives:

1. To determine the effect of brain-based learning model on students' achievement in current electricity.
2. To determine the effect of brain-based learning model on students' knowledge retention in current electricity.
3. To determine the effect of brain-based learning model on students' attitude to current electricity.

1.2 Research Questions

Based on the objectives stated, the following questions were raised to guide the study:

1. What are the mean achievement scores of students taught current electricity using brain-based learning model and those taught using the conventional method?
2. What are the mean knowledge retention scores of students taught current electricity

using brain-based learning model and those taught using the conventional method?

3. What are the mean attitudes of students taught current electricity using brain-based learning model and those taught using the conventional method?

1.3 Research Hypotheses

Based on the research questions raised, the following research hypotheses were formulated and tested at; 0.05 level of significance to further to guide the study:

H_O1: There is no significant difference in the knowledge retention scores of students taught current electricity using brain-based learning model and those taught using conventional teaching method.

H_O2: There is no significant difference in the attitude of students to current electricity using brain-based learning model and using conventional teaching method.

2. MATERIALS AND METHODS

The design of this study was quasi-experimental design. The specific design is pre-test, post-test, non-equivalent group design. This design was adopted because intact classes from the two colleges of education were used, to serve as the experimental and control group, since it was not possible to have complete randomization of the subjects. The population consists of 63 students (33 in experimental and 30 in control group) from intact classes in the two Colleges of Education in Taraba State. Treatment was assigned to one of the Colleges, while the other served as the control group. In each of the Colleges, 100 levels Nigerian Certificate in Education (NCE) and 'A' Level students taking current electricity course in physics of 2016/2017 session were used as the sample for the study. Permissions were granted by Heads of departments from both schools and all students that participated in the study had full consent.

This study was carried out during a course on Current Electricity, two class-hours weekly over a four week period. The Brain-Based Learning instructional strategy which is student-activity-centred was used in the experimental group while the traditional teaching approach which is teacher-activity-centred was employed in the control group.

The Brain-Based Learning model that was used in the "current electricity" lesson was integrating the three instructional learning techniques by Duman (relaxed alertness, orchestrated immersion and active processing) of the Brain-Based learning strategy [30]; and the seven Brain-Based Learning Principles by Caine et al. where detailed attention was given to seven main steps: (1) activation; (2) clarify the outcome and paint big picture of the lesson; (3) making connection; (4) doing the learning activity; (5) demonstrate student understanding; (6) review for student recall and retention/closure; and (7) preview the new topic [24]. These seven principles that were implemented are explained briefly as follows:

(i) Activation: This is the phase where we activate students' memory processor system (prior knowledge) in order to stimulate their learning transfer process.
(ii) Clarify the outcomes and paint the big picture: This the phase where students affirm for themselves their personal performance target, activate the right brain processor prior to the left brain, and alleviate anxieties over the accessibility and relevance of the material.
(iii) Making connection and develop meaning: This is the stage where the topic or unit of work about to be completed builds on what the learners already know and understand and helps them assimilate and integrate new information.
(iv) Doing the learning activity: This is the stage which immerses students in multisensory experiences for digesting, thinking about, reflecting on and making sense of experience utilizing visualization, auditory, kinesthetic in multiple contexts as well as to access all of the multiple intelligences.
(v) Demonstrating students' understanding: This is the stage for brain-active processing where students are allowed to consolidate and internalize information effectively when they are actively engaged with the knowledge itself.
(vi) Review for students' recall and retention: This is the activity that stimulates working memory to summarize the lesson, which helps to strengthen the transfer process.
(vii) Preview the new topic: This is the experience that helps the brain pre-processor and the reptilian brain to focus on the new lesson in order to prepare the brain for the new learning activities.

In the brain-based learning model used for this study, different teaching strategies were explored and students were allowed to have a short break during the teaching. Provisions were also made for the students' relaxation during the lesson. The teacher created a relax alertness learning environment by engaging the learner in "brain gym," "drink water", "brain buttons, etc." exercises and; learners were encouraged to drink minimal quantity of water before and during class in this study which was a great fun and motivator to students as being experienced the first time in classroom environment. It is evident that learning can be hindered due to dehydration [20]. Cooperation and group-work opportunities were provided to enhance emotional awareness and relaxation. The teacher also creates a learning environment that fully immerses students in many educational experiences; eliminates fear in the learners while maintaining highly challenging environments. The learners are also allowed to consolidate and internalize information by actively processing it. The active learning process involves "questioning and deep thinking" and "asking question is the basic condition required to think". Students were also allowed to walk around the classroom to discuss freely and brainstorm. The students were also encouraged to learn in their context and relate them to their existing knowledge learning activities organized based on the students' everyday experiences on Current Electricity concepts (electric current, electromotive force and circuits, Ohm's law, resistors in series and measurement of resistance by ammeter) applicable in this study.

To identify students' preferred learning method and to promote student interest, lessons are designed by questioning students about lesson topics without providing answers. The instructor directs the students to work on activities or experiments either individually or cooperatively with their peers. This period focuses on acquiring skills, such as planning, organizing, arranging, identifying presentation methods, collecting data, installing devices, taking notes, drawing associations between variables and reporting results. Further, the teacher asks leading questions and encourages students to discuss their contributions to provoke excitement, interest and curiosity so that learning from practical activities occurs in an integrated and inclusive manner. Next, the teacher uses basic ideas written on the board to guide effective student-student and student-teacher discussions. Students are instructed to find solutions to problems in the classroom either individually or in groups to enhance emotional awareness and relaxation. The lesson ended with a few questions aiming to remind the students of the topic of the following lesson and to arouse interest and curiosity.

In the control group, a lecture-based teaching method that was teacher-activity-centred was employed, and approaches used in the experimental group were not capitalized upon. For the control, the class was by conventional teaching method controlled entirely by the teacher without any break, relaxation or refreshment. The content in the control group was the same as the content dealt with in the experimental group and lecturing and question-answer methods were used to do the activities.

The instruments used for data collection was Current Electricity Achievement Test (CEAT), consisting of 20 multiple choice questions; and 4point- attitude scale consisting of 10 items. Before and after the experimental process; achievement test were implemented as pretests-posttests to experimental and control groups. Besides, after two weeks, students' were involved in 'questioning and answering session' to determine their understanding on Current Electricity concepts (electric current, electromotive force and circuits, Ohm's law, resistors in series and measurement of resistance by ammeter) and also the achievement test (CEAT) was implemented again as retention test to both two groups to determine students' knowledge retention. This pre-test was administered to the groups to equalize their pre-knowledge about the topics to be taught in Current Electricity to ascertain the psychometric properties of the test items (difficulty, discrimination indices and reliability coefficient). In each test item, the correct answer was determined as "2" point and at this state the highest point was determined as "40" point given a minimum score of '0' or 2 and the maximum score of 40. The instrument, CEAT was validated by physics experts to verify content validity in terms of scope, relevance, and clarity and simplicity of language/usage. The method of estimating the reliability of CEAT used is the Coefficient of internal consistency, specifically; the Kuder-Richardson formulae ($K\text{-}R_{20}$), which gave reliability value of 0.90.

The Attitude scale which was developed to determine the attitude of students towards Current Electricity course which consists of 10 items. In 4-Likert scale, answers of students were classified from the most positive to negative; “strongly agree”, “agree”, degree”, “strongly disagree respectively; having a maximum score of 4 and minimum of 1. The instrument, attitude scale was validated by experts to verify content validity in terms of scope, relevance, and clarity and simplicity of language/usage; in order to determine students’ attitude “positive or negative” towards Current Electricity. The attitude scale reliability value was determined with Cronbach Alpha (α) with a reliability coefficient of 0.72.

In this study, the "Likert data", and the values of the data are not numeric but respondents ticked "strongly agree", “agree", "disagree", and "strongly disagree". Before analyzing the data, the numerical values were translated for each item for each scale since this cannot be handled by any inferential statistical analysis, a random variable that assigns a numeric value and a probability value to each of these possible outcomes was assigned having maximum score of 4 and minimum of 1; that is 4, 3, 2 and 1 respectively. The t-statistic for this study is based on the underlying assumption that the data (Likert scale) have normal distribution of variable, data from both groups have same variance (using Levene’s Test for equality of variances), data are independent (using independent sample tests) and data have a linear relationship where the mean in known, or assumed to be known (using t-test for equality of means). It is also assumed that the variable (attitude) is measured on an interval scale. In taking the decision rule, any item whose mean is equal or greater than 2.50 ($X \geq 2.50$) was regarded as positive attitude, while any item whose mean is less than $X < 2.50$ was regarded as the negative attitude.

The hypotheses tested are null hypotheses with stochastic equality, which is involving or showing random behaviour where the probability of observing a higher value in one of the groups is .05. A significance test in this study is only testing the null hypothesis (H0). As applicable in this study, in a t-test for a null hypothesis of differences, the p which is less than .05 would indicate a significant difference between the two means, but if the means were found similar, the p should be more than .05 which indicates no significant difference between the two means, thus accepting the null hypothesis and rejecting the alternate hypothesis. As indicated from this statistical model used by the researchers in this study, the p-value gives the probability to get test statistics from a random variable that are at least as "extreme" as the one calculated from the data - under the assumption of a statistical model that is restricted to a given null hypothesis. Therefore, the $p<0.05$ criterion became a kind of a quasi-standard to judge if one would want to reject the null hypothesis in this study.

The responses to the items of both instruments were analyzed through the use of SPSS 16.0 version. The research questions were answered using descriptive statistics- mean and standard deviation; and the hypotheses were tested with independent samples t-test, all at 0.05 level of significance.

3. RESULTS

These results are presented based on the research questions and then the hypotheses.

Research Question 1: What are the mean achievement scores of students taught current electricity using brain-based learning model and those taught using the conventional method?

From the Table 1, the result revealed that the mean achievement scores of students taught in the experimental group at pre-CEAT were 4.54 with a standard deviation of 1.86. The mean achievement score of post-CEAT was 12.75 with the standard deviation of 2.92. Therefore, the mean gained or achievement between the post-CEAT and the pre-CEAT of the experimental group as shown in Table 1 was 8.21.

For the control group, Table1 showed that the mean achievement scores at pre-CEAT are 4.46 and at post-CEAT is 10.79 with their standard deviations as 1.74 and 1.67 respectively. Therefore, the mean gained or achievement between the post-CEAT and pre-CEAT of the control group, as shown above, was 6.33.

Research Question 2: What are the mean knowledge retention scores of students taught current electricity using brain-based learning model and those taught using the conventional method?

Table 2 showed that the mean knowledge retention scores of students taught current electricity using brain-based learning model (experimental group) at repost-CEAT is 11.83 with standard deviation of 2.66, while for the control group (conventional teaching method)

Table 1. Mean statistics showing the mean achievement scores of students taught current electricity using brain-based learning model and conventional teaching method

Group	N	Pre-CEAT X	SD	Post-CEAT X	SD	Mean difference
Experimental	33	4.54	1.86	12.75	2.92	8.21
Control	30	4.46	1.74	10.79	1.67	6.33

Table 2. Mean statistics of the knowledge retention scores of students taught current electricity using brain-based learning model and conventional teaching method

Group	N	Pre-CEAT X	SD	Post-CEAT X	SD	Mean difference
Experimental	33	12.75	2.92	11.83	2.66	0.92
Control	30	10.79	1.69	7.04	1.92	3.75

has repost-CEAT mean value of 7.04 with standard deviation of 1.92. Therefore, the mean lost between repost-CEAT and post-CEAT are 0.92 and 3.75 for experimental and control group respectively.

Research Question 3: What is the mean attitude values of students in current electricity exposed to brain-based learning model and those exposed to the conventional method?

Table 3a and 3b revealed that the mean attitude values of students in the experimental and control group respectively, before treatments were manipulated. The result showed that the two groups are similar, having students of negative attitude towards the study of current electricity in physics.

Table 3c revealed that the students of the experimental group have a positive attitude towards current electricity after treatment has been manipulated on them showing all the means >2.5; starting from item1 to item10. The response scores seemed to be of higher mean per item (greater than 3.5) on a 4-point Attitude Scale. Whereas on Table 3d; the result showed that the students of the control group have positive attitude of mean >2.5 only for item 1, but negative attitude towards the other items; 2 to 10, which seemed to be of lower values (lesser than 2.5 test-value) in a 4-point Attitude Scale. This implies that students in the experimental group acquired higher and positive mean attitude value at the post-attitude than their counterparts in the control group. It presents the post-attitude mean of the experimental and control group as 3.65 and 2.07 respectively.

Hypothesis One: There is no significant difference in the knowledge retention scores of students taught current electricity using brain-based learning model and those taught using conventional teaching method.

Further analysis was conducted to test whether the difference in the means observed in the Tables 4 was statistically significant. The significant value (.080) is greater than 0.05, hence, the first line of scores (equal variance assumed) in the table is considered for interpretation. The t-test value was 7.145, Df was 61 and p-value was 0.000. Since the p-value is less than 0.05 level of significance, therefore there is a significant different between the knowledge retention of students in the experimental group (brain-based learning) and the control group (conventional teaching method), with the mean of experimental group recording 11.8333; indicating significantly retained knowledge compared to the mean of control group, recording 7.0417. The results, therefore, revealed that the experimental group which had engaged in brain-based learning produced a higher overall improvement in scores on the current electricity delayed retention test scores used to determine students' knowledge retention which showed that Brain-based learning, which was implemented to the experimental group, provided more retentive learning. Thus, the null hypothesis is rejected.

Hypothesis Two: There is no significant difference in the attitude of students to current electricity using Brain-Based Learning model and using conventional method.

Table 3. Descriptive statistics of students' mean attitude exposed to brain-based learning model and those exposed to the conventional method

	3a. Descriptive Statistics of Experimental Group	(PRE-ATTITUDE)			
S/N	**Items on opinions of students towards current electricity**	**N**	**Minimum**	**Maximum**	**Mean**
1.	Learning about current electricity makes me give quality time in studying it	33	1	3	1.666667
2.	Mentioning of current electricity do not scare or threaten me.	33	1	3	1.458333
3.	The best way to learn current electricity is either to teach my classmate	33	1	3	1.208333
4.	I like current electricity. It is interesting, engaging and fun	33	1	3	1.583333
5.	Knowledge of current electricity enables me to understand my physical environment better.	33	1	3	1.25
6.	The knowledge of current electricity can be applied to solve many practical problems even related to my everyday life.	33	1	3	1.708333
7.	I know my capability better in current electricity when I answer past question and confirm the answer myself.	33	1	3	1.625
8.	I feel so good reliable & responsible I share with my classmates what I know about current electricity	33	1	3	1.416667
9.	Failing question in current electricity makes me to think of how to correct myself and gather confidence next time	33	1	3	1.916667
10.	The teaching and learning of current electricity among classmates can train students to be tolerating, cooperative and self-disciplined	33	1	3	1.666667
	ValidN(listwise)	33			

MEAN ATTITUDE OF TOTAL MEAN = 1.55

	3b. Descriptive Statistics of Control Group	PRE-ATTITUDE)			
S/N	**Items on opinions of students towards current electricity**	**N**	**Minimum**	**Maximum**	**Mean**
1.	Learning about current electricity makes me give quality time in studying it	30	1	2	1.75
2.	Mentioning of current electricity do not scare or threaten me.	30	1	2	1.5
3.	The best way to learn current electricity is either to teach my classmate	30	1	2	1.458333
4.	I like current electricity. It is interesting, engaging and fun	30	1	3	1.791667
5.	Knowledge of current electricity enables me to understand my physical environment better.	30	1	3	1.416667
6.	The knowledge of current electricity can be applied to solve many practical problems even related to my everyday life.	30	1	3	1.875
7.	I know my capability better in current electricity when I answer past question and confirm the answer myself.	30	1	3	1.625
8.	I feel so good reliable & responsible I share with my classmates what I know about current electricity	30	1	2	1.458333
9.	Failing question in current electricity makes me to think of how to correct myself and gather confidence next time	30	1	3	1.708333
10.	The teaching and learning of current electricity among classmates can train students to be tolerating, cooperative and self-disciplined	30	1	3	1.666667
	ValidN(listwise)	30			

MEAN ATTITUDE OF TOTAL MEAN = 1.4833

3c. Descriptive Statistics of Experimental Group (POST-ATTITUDE)

S/N	Items on opinions of students towards current electricity	N	Minimum	Maximum	Mean
1.	Learning about current electricity makes me give quality time in studying it	33	3	4	3.75
2.	Mentioning of current electricity do not scare or threaten me.	33	2	4	3.583333
3.	The best way to learn current electricity is either to teach my classmate	33	3	4	3.666667
4.	I like current electricity. It is interesting, engaging and fun	33	1	4	3.458333
5.	Knowledge of current electricity enables me to understand my physical environment better.	33	3	4	3.708333
6.	The knowledge of current electricity can be applied to solve many practical problems even related to my everyday life.	33	3	4	3.625
7.	I know my capability better in current electricity when I answer past question and confirm the answer myself.	33	3	4	3.533333
8.	I feel so good reliable & responsible I share with my classmates what I know about current electricity	33	3	4	3.625
9.	Failing question in current electricity makes me to think of how to correct myself and gather confidence next time	33	3	4	3.833333
10.	The teaching and learning of current electricity among classmates can train students to be tolerating, cooperative and self-disciplined	33	3	4	3.625
	ValidN(listwise)	33			

MEAN ATTITUDE OF TOTAL MEAN = 3.645833

3d. Descriptive Statistics of Control Group (POST-ATTITUDE)

S/N	Items on opinions of students towards current electricity	N	Minimum	Maximum	Mean
1.	Learning about current electricity makes me give quality time in studying it	30	2	4	2.916667
2.	Mentioning of current electricity do not scare or threaten me.	30	1	3	2.125
3.	The best way to learn current electricity is either to teach my classmate	30	1	4	2.25
4.	I like current electricity. It is interesting, engaging and fun	30	1	3	2.291667
5.	Knowledge of current electricity enables me to understand my physical environment better.	30	1	3	2
6.	The knowledge of current electricity can be applied to solve many practical problems even related to my everyday life.	30	1	3	2.041667
7.	I know my capability better in current electricity when I answer past question and confirm the answer myself.	30	1	3	1.833333
8.	I feel so good reliable & responsible I share with my classmates what I know about current electricity	30	1	3	1.583333
9.	Failing question in current electricity makes me to think of how to correct myself and gather confidence next time	30	1	3	1.791667
10.	The teaching and learning of current electricity among classmates can train students to be tolerating, cooperative and self-disciplined	30	1	3	1.875
	ValidN(listwise)	30			

MEAN ATTITUDE OF TOTAL MEAN = 2.070833

Table 4. Independent Samples t-test results regarding knowledge retention test scores of the experimental and control group

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SCORES	EXP	33	11.8333	2.66485	.54396
	CTRL	30	7.0417	1.92194	.39231

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for equality of means				
	F	Sig.	t	Df	Sig (2tailed)	Mean Difference	Std. Error Difference
Equal variance assumed SCORES	3.207	.080	7.145	61	0.000	4.79167	.67067
Equal variance not assumed			7.145	56.832	0.000	4.79167	.67067

Table 5. Result of independent samples t-test about students' attitude towards current electricity using Brain-Based Learning Model and using Conventional Method

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
TOTAL	EXP	33	36.4583	2.30272	.47004
	CTRL	30	20.7083	2.27423	.46422

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	Df	Sig (2tailed)	Mean Difference	Std. Error Difference
Equal variance assumed SCORES	.023	.880	23.841	61	0.000	15.75000	.66064
Equal variance not assumed			23.841	60.993	0.000	15.75000	.66064

From the Tables 5, the t-test value was 23.841, DF was 61 and p-value was 0.000. Since the p-value is less than 0.05 level of significance, therefore there is a significant difference between the attitude of students in the experimental group (of brain-based) and the control group (of conventional method), with the mean of experimental group recording a total of 36.4583; indicating significantly positive attitude compared to the mean of control group, recording total of 20.7083. The mean difference observed was 15.75000 which imply the positive effect of the brain-based learning model. The study revealed that there is the significant difference in the attitude of students to current electricity using Brain-Based learning model compared to using conventional teaching method. Therefore, the null hypothesis was rejected. This implies that from the study, students in the experimental group acquired significantly higher and positive mean attitude value at the post-attitude, than their counterparts in the control group.

4. DISCUSSION OF FINDINGS

The results presented above showed that the pre-CEAT mean scores of the experimental and control group are 4.54 and 4.46 respectively. The low pre-CEAT achievement scores show that the students had low prior knowledge of current electricity content that was taught before the study, but the use of brain-based learning model improved their achievement significantly as observed in the post-CEAT scores; 12.75 and 10.79 as found in the experimental and control group respectively. These findings are in agreement with Philip cited in Umoru, declared that Brain-based increases students' achievement and provides equal opportunities for individual differences [31,19]. It is observed that brain-based is a powerful learning strategy to promote unique understanding and achievement of students.

The results also revealed that the repost-CEAT scores of the experimental and control group are 11.83 and 7.04 respectively, showing mean difference of 0.92 and 3.75 respectively. This mean difference implies that the mean lost between repost-CEAT and post-CEAT of the brain-based group is not significant for diminishing knowledge retention when compared with their conventional counterpart. This is in line with Saleh; the brain-based teaching approach was effective in enhancing students' scientific understanding of Physics (current electricity inclusive) [7,8]. Based on the above findings from the study, it is not out of place to state that if a good learning or teaching strategy like brain-based learning model is used in teaching difficult topics like current electricity, the students will definitely have lasting retention of knowledge. This outcome helps to re-assure Hutchins, brain based learning is still a questionable practice and further empirical research is warranted [34]. It also supports the findings of Jack and Kyado, whose results revealed that brain-based learning, which was implemented to the experimental group, provided more retentive learning [27].

The findings related to the mean retention scores of students showed that the experimental group which had engaged in brain-based learning produced a higher overall improvement in scores on the current electricity lesson delayed retention test scores used to determine students' knowledge retention or more retentive learning than the control group that used conventional teaching method. The findings of this study imply that brain-based learning had much more positive effect on students' learning and retention compared to conventional teaching method [20, 27, 30]. The findings, therefore, revealed that there were positive mean gains in brain-based learning since the current electricity lesson was taught in compliance with the working principles of the brain, and positive contributions were made on students' academic achievement [20, 27,30]. The results showed a statistically significant difference between the retention test scores of experimental and control group in favour of the experimental group. This showed that the experimental group that used brain-based learning provided realization of knowledge retention of Current electricity concepts than the conventional teaching method that was through memorization since they were not engaged in practical activities in the physics class.

Also, the data analysis on pre-attitude revealed that the two groups have similar negative attitude mean of 1.55 and 1.63; showing that students' interests believe, motivations, co-operation, confidence, reliance and value to current electricity content is poor, resulting to negative attitude among students in colleges of education. The outcome of analysis after treatment, presented all the students of the experimental group to have acquired significantly positive attitude (having mean scores greater than 3.0 for each of the 10 items). The students of control group acquired the insignificant increase in attitude (having mean scores lesser than 2.5 level of significance for 9 items). However, the results showed that students' attitude improves significantly at the control group, only for item 1; declaring that "Learning about current electricity makes me give quality time in studying it". This agrees with the fact that processing time and reflection are also vital to the learning environment in order to enhance positive attitude and knowledge retention in learners. The total mean (36.46) of the experimental group is relatively high compared to the total mean (20.71) of the control group. This general relationship is based on the concept that the positive attitude a student has towards a subject or task, the higher the achievement or performance level tends to be [6]. The result also agrees with Weaver; it is 'attitude, not aptitude that determines altitude' and he commented that students with a positive optimistic attitude do better in colleges [13]. This implies that the use of brain-based learning model contributes greatly to positive attitude of students toward current electricity content. This is in line with Saleh, students who followed the Brain-based learning model possessed a better Physics learning motivation (attitude in general) compared to students who received

Conventional Teaching Method [7,8]. However, the findings of this study disagree with the works of Aydın, Yıldırım, Getz, and Samur; revealing that the Brain-based learning model neither had an influence on students' attitudes nor led to changes in their attitudes towards science courses; Current Electricity, a Physics course inclusive [9,10,32, 33].

The brain-based learning model used in this study, therefore, helped in the provision of the enriched learning environment, well-designed brain-compatible instructional materials and judicious use of varied strategies in brain-based learning that had helped to put minimal fear and undesirable attitude amongst students taught physics concepts primarily on "current electricity". The brain-based learning helped in improving students' achievement, attitude and retention since it was associated with the principle for relax -alertness which eliminated fears in the learner, while maintaining a highly challenging learning environment in physics class.

5. CONCLUSION

Brain-based learning model was found to be a better instructional strategy when compared with the conventional teaching method. It is preferred for better achievement and increased knowledge retention of difficult concepts. Brain-based learning strategy also contributes greatly to promote higher positive attitude among learners in the Current Electricity lesson. This clearly explains that when learners are taught with meaningful and active practical activities in a thematic way with appropriate innovative learning in a critical thinking and problem-solving skills; they feel more comfortable, self-confident and motivated in the classroom, which may, in turn, help them to gain success in achievement and retention.

6. STUDY LIMITATION

In respect to the class size very few students offer Physics in Taraba state, North-Eastern part of Nigeria. Discussions of results in terms learning gains were improved upon and available literature on mean gain was stipulated. The following cross-sectional study is done with only a few samples as the matter of prospect is very integrative in nature and need more time to avail.

7. RECOMMENDATIONS

In view of the above conclusion and discussion of findings in this study, the following recommendations were made:

1. Physics teachers should adopt brain-based learning model in teaching physics concepts primarily on "current electricity" than the conventional teaching method since it enhances better learning outcome and knowledge retention in learners.
2. Brain-based learning model should be adopted for use in physics (Current Electricity in particular) and other science courses so as to promote positive attitude in students.
3. Evidence from research suggests that stress has a significant influence on students' creativity, memory, behavior and learning. Teachers therefore, can imbibe a science classroom friendly environment to decrease stress in students' through positive strategies such as incorporating recess, teaching coping skills and integrating stretching exercises used in Brain-brain learning model since it enhances physics students' achievement, attitude and knowledge retention through problem solving and thinking skills like critical thinking, decision-making and creative thinking.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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