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Impact of the Brain-based Instructional Model on Science Learning

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ABSTRACT
The study investigates the impacts of the brain-based instructional model on science learning. The research uses a mixed-method approach. The quantitative data for the analysis was obtained through a quasi-experimental design and qualitative data through a semi-structured interview. Sixty science education students of a College of Education students were sampled for the study. The study provided answers to three research questions. The data obtained were triangulated and analyzed using Analysis of Covariance (ANCOVA), descriptive statistics, and thematic coding. Findings revealed that the brain-based enhances students' academic performance; besides, male and female students do not respond differently to the instruction. The study also promotes students' interest in science learning, motivation, and retention.Finally, the research discussed some implications on the educational system of the nation. The study recommends that schools in Nigeria adopt the model to teach science at all levels, and further research is required.

Keywords: Brain,Intelligence, Learning,Neuroscience, Pedagogy,Science Education.

I. INTRODUCTION

The academic performance of science students in Nigerian schools is not encouraging, as many studies revealed. For example, Onanuga and Saka (2018), in their research of trend analysis of students' academic performance in selected STEM in Ogun state, observed poor academic performance. However, this is not peculiar to Nigeria but a global issue. For example,Kirui and Kaluyu (2018) argued that poor academic performance in Kenya schools is a worldwide challenge, not only in Kenya.

Research studies indicate that male students performed better and haveinterests in certain science subjects than their female counterparts (Akweya, Twoli & Waweru, 2015). Many studies documents that teaching strategies contributed significantly to this problem (Wanbugu & Changeiywo, 2008; Riveros, 2012; Mekonnen, 2014). Most teachers teach to satisfy the curriculum with little or no consideration for the students. Today, most students have no interest in science learning because they are not motivated by the teacher through the teaching strategies employed. Students' learning becomes challenging when there is no motivation (Rehman & Haider, 2013). Given this, many of them memorized science concepts because the retention rate is low and quickly forgot what they learned a few minutes after the lesson. Student retention is a significant challenge to learning in higher education (Scott, Shah, Grebennikov & Singh, 2008).

Teachers in most educationally advanced countries in the 21st century have shifted attention from teaching to learning. Therefore, their primary focus is that students learn and do everything to achieve it. To accomplish this require the interplay of research-based pedagogies against the traditional paradigm of teaching. Research indicates that students in science classes have different learning styles, and therefore, the intelligence is multiple, not just a single collective intelligence quotient (I.Q.) (Aina, 2018). Hence, teachers should always adopt teaching strategies that meet the need of learning style of every student.

The study of science in Nigerian schools is challenging today because of many factors. Significant among these factors is the teachers' method of teaching. The quality of teachers is the ability to motivate students to learn science (De Silvai and Azam 2018) through good teaching strategies. According to Amir, Mohamed, and Mnjokava (2016), the science students' academic performance in Uganda is equally not encouraging as in other countries.Most Nigerian science

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teachers' strategies have challenges of making the paradigms fit for 21st-century science. These teaching strategies are the lecture method, demonstration, project, inquiry, and, recently, computer-aided instruction (C.A.I.). These methods have been criticized because of their weaknesses.

The lecture method is criticized as a one-wayparadigm of instruction, rendering classes inactive (Gehlen-Baum & Weinberger, 2014). Similarly, Afolabi, Izuagba, Obiefuna,and Ifegbo (2014) averred thata lecture method is a teacher-centeredapproach thatmakes learning superficial andstudents passive.The demonstration method is frequently designed to allow students to observe instead of hands-on laboratory activity (McKee, Williamson, & Ruebush, 2007).Choosing content, managing time, poor facilities, assessment,monitoringare some of the problems of project-based instruction (Aldabbus, 2018).According to Löfgren, Schoultz, Hultman,and Björklund (2013), students are encouraged to study and evolve the right attitudes for learning science when participating in inquiry tasks. The inquiry method demands that the students have the required repertoires before going for the inquiry training. If students do not have the needed repertoires, inquiry learning may fail, and students might be frustrated (Kuhn, Black, Keselman & Kaplan, 2000). One significant problem of this CAI is the inadequate functional computer in Nigerian schools (Bakare, 2017). Thus, science teachers should as much as possible take care of the needs of all categories through research-based instructions.

Learning science through peer instruction is a research-based strategy that enhances learning. The method relied much on students teaching themselves through dialogical argumentation. Students control the learning process while the teacher scaffold and coaches. The social and cognitive interactions are essential in this learning pattern and, thus, the critical role of constructivism and constructive controversy theories. Teaching and learning are evolving. Thereforeno single teaching model could meet the present needs of students. Nonetheless, the need to consider the uniqueness of the learners' brains in learning is critical to understanding.

According to Gladys, Stella, and Omobolanle (2018), the brain-based learning instructional model is a learner-centered and teacher-facilitated method that employs learners' cognitive gifts (endowments). This is viewed as techniques gathered from neurology and cognitive science research to enhance teacher instruction (Connell, 2009). Brain-based learning is learning aligned with the brain's workings and designed naturally to learn (Mekarina & Ningsih, 2017). There are shreds of evidence that many countries have been using brain-based learning in their schools for instructions; these nations include the U.S.A., Turkey, Chile, England, Thailand, and others (Connell, 2009).

The model anchors its effectiveness on twelve principles (Caine and Caine 1990), as stated below.

- The brain is a parallel processor
- Learning engages the entire physiology
- The search for meaning is innate
- The search for meaning occurs through patterning
- Emotions are critical to patterning
- Every brain simultaneously perceives and creates parts and whole
- Learning involves both focused attention and peripheral perception
- Learning always involves conscious and unconscious processes
- We have two types of memory systems: spatial and rote learning
- The brain understands and remembers best when facts and skills are embedded in natural spatial memory
- Learning is enhanced by challenge and inhibited by threat
- Every brain is unique

Most science teachers depend on much of the subject contents and therefore overwork the learners' brains. Brain-based learning believes in students' activities, recess, refreshments, and water drinking to avoid dehydration during learning. According to Jensen (2014), Physical activities, recess, and movement support learning critical to student learning. Therefore, the infusion of the break, refreshment, drinking of water, and physical activities in classroom teaching is imperative (Jensen, 2014; Prince, 2005). The preliminary investigation of brain-based learning in physics class by Aina and Ayodele (2018) shows it fosters understanding and improves students' academic performance.

In light of the above, this study shall investigate the impacts of the brain-based learning model on science students'academic performance in a College of Education, Nigeria. Specifically, the research shall examine the impacts of the brain-based on science learning.

The choice of the College of Education is to solve the dysfunctions of science pedagogies from the grassroots. The National Certificate in Education (N.C.E.) holders are mandated to teach

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in primary and junior secondary schools (The Basic education level) in Nigeria.

1.1 Statement of the Problem

Science teaching in Nigerian schools is erroneously perceived to be difficult because of teaching strategies employed by teachers (Wanbugu &Changeiywo, 2008). Several studies on teaching pedagogy in science were published in an attempt to resolve the problem, and the challenges persist. For instance, various studies on inquiry learning, interactiveengagement, peer instruction, and others show this challenge (Popoola & Olorundare, 2017; Aina, 2018). However, as good as these studies might be, many do not consider the role of the learners' brains in the learning process. Empirical studies show that learners' brains are unique and must be adequately recognized for learning. Both the teacher and the students seem to forget that the brain is connected with everything in school. According to Jensen (2014), any attempt to disconnect this will lead to failure, frustration, and disaster in teaching and learning, as we witness in science education today in Nigeria. The recent study by Gladys, Stella, and Omobolanle (2018) revealed that the brain-based learning model enhanced students' retention and attitude towards Physics in two Colleges of Education in Taraba state, Nigeria. However, Gladys et al. (2018) is only in Physics and investigated limited brain-based learning principles. The current study is on science and shall widen the scope of brain-based learning principles. Given this, the research examines the impacts of the brain-based paradigm on science learning in a Nigerian College of Education.

1.3 Purpose of the Study

The study's primary purpose is to investigate the effectiveness of the brain-based learning paradigm among science students in a College of Education, Nigeria. The study shall determine the following:

1. The effect of brain-based learning on the students' academic performance in science
2. The gender gap between the students who participated in brain-based learning instruction.
3. The impact of the brain-based model on students' learning

1.4 Research Questions

The study shall achieve the purposes mentioned above by providing answers to the following research questions:

Q_{01}: Does brain-based learning instruction have an impact on students' academic performance in science?

Q_{02}: Is there a gender difference in students' academic performance who participated in the brain-based learning instruction?

Q_{03}: Does the brain-based model have an impact on the students' learning?

1.5 The scope of the Study

The study was limited to the students in science education in a College of Education in Kwara state. The research study was conducted among students in the Department of Chemistry, Integrated Science, and Physics. The rationale for choosing students in these departments is that there are science courses all these students offer together. For instance, molecular theory and electrolysis are topics common to all students in these departments.

II. RESEARCH DESIGN

The research is a mixed-method involving quantitative and qualitative data. A quasi-experimental design was used to obtain quantitative data, while an interview was used for qualitative. This approach provides a more reliable comprehension of the problems under investigation better than a single approach (Johnson & Christensen, 2014). Furthermore, it gives readers more confidence in the research results and conclusion (McKim, 2017). This method equally gives a shred of robust evidence for investigating a problem better than quantitative or qualitative research. Additionally, it provides answers to questions that qualitative or quantitative approaches alone cannot answer. The process of mixed- methods in research like this with the interview could produce more valid and reliable outcomes (Terrell, 2011).

It is a pretest-posttest control group approach. In this design, the researcher made use of intact classes for experimental and control groups. The design is primarily explored in education for its strength in controlling internal validity threats (Gopalan Rosinger & Ahn, 2020).The symbol system of the technique is given and defined below.

Experimental Group: O_1 X O_2

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Control Group: O_3 O_4

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The broken line indicates intact groups; O1 and O3 represent pretest, X represents treatment, and O2 and O4 represent posttest.

Sixty students of Biology, Chemistry, Integrated Science, Physics education were sampled for the study. This cohort of students were in two groups, experimental and control. The experimental group received lecturesusinga brain-based learning model for six weeks within a semester, followed by a semi-structured interview. The control group usedthe lecture method.

2.1 Experimental Group

This group always had a one-hour lecture every week. However, the research instrument, the Brain-based Learning Model Test (BbLMT), was administered before the intervention (pretest), and followed by an interview after the intervention. The same instrument was administered the second time at the end of the intervention (posttest).

The one-hour lecture was in four stages. The first stage took thirty minutes of class discussion guided by the instructional programme prepared by researchers. During this period, the instructor spent thirty minutes. The second stage lasted for ten minutes. Students at this stage were released to go outside the class to walk around, interact with each other, take snacks, and drink water. At this stage, some students may not be willing to go out for recess, but the instructor encouraged such students to do so. The encouragement was with politeness, not with force, because of ethical guidelines. After the ten minutes of recess, the students returned to the third stage for fifteen minutes of class discussion. Again, they were taught for fifteen minutes using the instructional programme. The last step was five minutes of students' reflection before leaving the class to close the lecture for the day. The final stage for the group was the interview section, which was conducted in a conducive environment. Interview in research explores interviewees' opinions, beliefs, and experiences on a particular issue of interest (Gill, Stewart, Treasure& Chadwick, 2008). The current research is on students' experience with the brain-based learning model.

2.2 Control Group

The group received a lecture for one hour using the instructional programme prepared by the researchers. The students always have the lecture for one hour without any recess. Meanwhile, there was a pretest using the research instrument, Brain-based Learning Model Test (BbLMT), before the lecture for this group. The same test was administered after the group had completed all the classes (posttest).

2.3 Research Instrument

The research instruments for this study are the Brain-based Learning Model Test (BbLMT) and semi-structured interview. The researchers administered the BbLMT to both groups at the start of the course to obtain pretest data. BbLMT contains multiple-choice questions from biology, chemistry, integrated science, and physics. The questions were based on the science education curriculum for the Nigerian Colleges of Education. At the end of the six weeks of the lecture, the researchers repeated the test for the groups to get posttest data. The interview protocol is only applied to the experimental group.

2.4 Data Analysis

The data obtained from the questionnaire and interview were triangulated. Analysis of Covariance (ANCOVA), descriptive statistics thematic coding were used for data analysis.

2.5 Reliability and Validity

The validity refers to how a measuring instrument has measured what it is designed to measure (Ramaligela, 2013). The tool was the adapted science education questions drafted and scrutinized by three science education experts.

2.6 Ethical Considerations

The dignity and integrity of the participants are critical to any research involving human beings, which this study did not violate. For anonymity purposes, the actual name of the sampled college and studentswere not disclosed (pseudonym) throughout the research study. Anonymity was applied to the collation of data from the BbLMT. The information recordedwould remain in the custody of the researchers for safekeeping until such time that it can be disposed of safely.

III. RESULTS AND DISCUSSION

3.1 Results

Table 1 presents descriptive statistics of pretest and posttest scores of the two groups. Table 2 is the ANCOVA of gender.

Question 1: Does brain-based learning instruction have an impact on students' academic performance in science?

Table 1

Pre-post mean scores of Control and Experimental Groups

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	Pretest		Posttest	
	Control Group	Expt. Group	Control Group	Expt. Group
N	30	30	30	30
S.D	11.13785	11.26999	11.11052	11.30360
Mean	40.5000	42.4333	53.7333	55.4333

Table 1 shows a difference in the mean scores of students who participated in the brain-based and those who did not. The mean score of students who participated in brain-based learning is 55.4333, and those who did not participate is 53.7333, as indicated in the table.

Question 2: Is there a gender difference in students' academic performance who participated in the brain-based learning instruction?

Table 2
ANCOVA of gender academic performance in the brain-based instruction
Dependent Variable: final exam

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1856.121[a]	4	464.030	4.664	.003	.253
Intercept	4401.810	1	4401.810	44.240	.000	.446
Pretest	1710.065	1	1710.065	17.187	.000	.238
Gender	9.145	1	9.145	.092	.763	.002
Group	.007	1	.007	.000	.994	.000
gender * group	245.279	1	245.279	2.465	.122	.043
Error	5472.462	55	99.499			
Total	186089.000	60				
Corrected Total	7328.583	59				

Table 2 shows that brain-based instruction has no significant impact on students' academic performancebased on gender. It implies male and female does not respond differently to brain-based instruction. The Sig. (2-tailed) of the gendergroup is 0.122, higher than the probability value of 0.05.

Many responses from the interview were recorded; however, the transcripts of a few of the interviewees were presented here based on the themes: students' learning experience, retention rate, and motivation.

Researcher: What can you say about your personal experience of the brain-based learning model?

Most students responded that the model was an exciting learning strategy. Some of the discourses were transcribed below.

Researcher: What can you say about your personal experience in the brain-based learning model?

AZKWO: It's exciting.

AKDDE: It was fascinating because students were active through the intervention period.

Researcher: How would you describe your learning in this intervention?

Nearly all students responded they remember what they learned quickly without the former way of memorization. However, a few said the rate of retention was medium.

KUDIA: Brain-based model of learning gave me higher retention.

ARTO: I remembered concepts I learned quickly without stressing to memorize them.

SCID: My retention rate was medium.

Researcher: What can you say about your motivation in this intervention?

All students said they were motivated to learn science with this model.

ADBA:I am highly motivated to learn science with this instructionparadigm because it is an active learning model.

OJAT:I was motivated.

3.2 Discussion

The outcome of this research indicates a mean difference between the group exposed to brain-based learning and the group that was not exposed to it. The difference between the groups might be due to the intervention because the

preliminary analysis shows the two groups wereat the same academic level before the intervention.

This research's finding is consistent with Noureen, Awan, and Fatima (2017) that students who participated in brain-based instruction performed better than those who did not. Tüfekçi and Demirel (2009)'s study concluded that brain-based learning positively influences students' learning and retention. According to Mekarina and Ningsih (2017), brain-based instruction enhances students' academic achievement and motivation. Gözüyeşil and Dikici (2014) meta-analysis research shows brain-based instruction positively impacts students' academic achievement. Sheikh (2020) observed that brain-based learning is significantly beneficial for students' cognitive learning for a particular grade of students in Kenya. According to Gladys et al. (2018), brain-based learning is an instructional paradigm found better than some other conventional strategies.

Brain-based instruction is a student-centered interactive engagement that enhances learning (Noureen, Awan & Fatima, 2017). Several previous studies on interactive engagement like peer group discussion or instruction enhance learning. For example,Fllade, Bello, Uwaoma, Anwanane, and Uwangburuka (2019) averred that peer learning has a significant impact on the academic performance of undergraduate students. Similarly, Bassey (2020) shows that peer grouping in learning influences students' academic performancesignificantly. In the same vein, Kaymak, Balta, Almas, Kazmagambet, and Mbala (2020) revealed that peer instruction positively impacts students' academic performance.

The finding of the study also shows the students' response to the brain-based is not gender bias. Male and female students do not respond differently to brain-based instruction. Gender issue in science has been a long-time debate among scholars. The outcome of this research is similar to the findings of some previous studies. Acar, Büber, and Tola (2015) found no gender difference in conceptual physics knowledge between Turkish students' low and high socioeconomic status. Inyang and Josiah (2016) observed no significant difference in achievement in a specific area of physics in some schools in Nigeria.

There is no gender gap in students' higher-order thinking skills (Ramos, Dolipas & Villamos, 2013). No significant gender difference in the Physics achievement with students taught with C.A.I. (Josiah, 2012). Conceptual understanding of elementary physics has no gender bias when interactive engagement is explored (Crouch & Mazur, 2001).Jia, Yang, Qian, and Wu (2020) said there is no gender difference in academic achievement in science in grade 4 and grade 8 in China.

Nwosu and Ndanwu (2020) found no significant interaction effect of gender and teaching strategy on the mean score of students' achievement in electronic libraries courses. Likewise,Atomatofa (2014) submitted a research finding that no gender difference in students' academic achievement because of the teaching method employed.

Instructional strategies employed by teachers are essential to the success of science teaching. Many scholars believe that science subjects are abstract and challenging because of the teacher's teaching paradigm. Poor academic performance and declining enrolment are critical problems of science in Nigerian schools today partly because of the issue of teachers' method of teaching (Aina & Ayodele, 2018). Research-based strategies like brain-based are rare in Nigerian schools among teachers. Students' learning of science and passing with good grades is a function of adequately engaging the brain (Bada, 2021).

Interest is critical to science learning (Potvin & Hasni, 2014). The outcome of the current research through the interview shows students had an interest in learning science with brain-based instruction. Research shows that the teaching method is crucial in determining students' interest in science learning (Potvin & Hasni, 2015). The result of this study on students' interest is not on the same page with Adu-Gyamfí (2013), who observed a decline in students' interest in science. The interview also indicates that students were motivated and had a high retention rate through the brain-based model. This is consistent with Gladys et al. (2018) that brain-based instruction enhances students' retention. Motivation is a critical construct in learning, as observed by Rehman et al. (2014). Motivation encourages students, and it determines successful learning (Nalevska & Kuzmanovska, 2020).

Given the results and the discussion above, the significant findings of the study are

- The mean score of students who participated in brain-based learning is higher than students in the conventional method. This suggests that students who participated in brain-based instruction have a better academic performance than those who did not.
- Male and female students do not respond differently to the teaching method used in this study. Therefore, it implies the student's responses to the brain-based model are not gender bias.

- Brain-based instruction impacts students' learning because it enhances their interest in science learning, motivation, and retention.

IV. CONCLUSION

The study is the impacts of the brain-based learning model on science learning in a College of Education in Nigeria. The study adopted a mixed-method approach. Sixty science students of a College of Education were sampled. There weretwo groups of thirty students in each group. The treatment group was subjected to brain-based instruction and interview, while the control group only received lectures through the conventional lecture method. The brain-based learning model test was administered at the beginning of the intervention and two months later. The data for the research was the scores obtained from the pretest and posttest and the interview. The data analysis using descriptive statistics, ANCOVA, and thematic coding shows that the model effectively enhances students' academic performance. Furthermore, male and female students do not respond differently to the model; it enhances students' interest, motivation, and retention.

4.1 The implication of the findings

The findings of this research have two significant implications on the Nigerian education system. Firstly, the education system requires more funds to provide students refreshment if schools adopt the brain-based model. Secondly, teachers must be trained to be able to use this model in schools. Presently in Nigeria, most science teachers do not know much about this strategy. Therefore, the Nigerian government would need to train teachers through workshops, seminars, and conferences through the ministry of education.

4.2 Recommendations

Given the above findings and conclusion, the recommendations below are suggested.

- Schools in Nigeria should adopt the model to teach science at all levels
- Government should make adequate funds available to provide refreshments for students.
- Workshops, seminars, and conferences should be organized for science teachers to train them about the model
- Further research on the brain-based is required to explore more benefits of the model.

REFERENCES

[1]. Acar, O., Büber, A.,&Tola., Z. (2015). The effect of gender and socioeconomic status of students on their physics conceptual knowledge, scientific reasoning, and nature of science understanding. Procedia - Social and Behavioral Sciences 174 (2015), 2753 – 2756

[2]. Adu-Gyamfí, K. (2013). Lack of interest in school science among non-science students at the senior high school level. Problems of Education in the 21st century, 53(2013), 7-21. DOI: 10.33225/pec/13.53.07

[3]. Afolabi, A., Izuagba, A., Obiefuna, C., & Ifegbo, P. (2015). Effects of the use of lecture method and word on the performance of students taught curriculum studies 1: EDU222. Journal of Education and Practice, 6(18), 142-149.

[4]. Aina, J. K. (2018). Physics learning and the application of multiple intelligences. Brazilian Journal of Environmental Management and Sustainability, 5(9), 381-391

[5]. Aina, J. K., & Ayodele, M. O. (2018). The application of brain-based learning paradigm in science education, Nigeria: A review. Journal of Scientific and Engineering Research,5(7), 325-331

[6]. Aldabbus, S. (2018). Project-Based Learning: Implementation & Challenges. International Journal of Education, Learning and Development, 6(3), 71-79

[7]. Al Quraan, E. J.,&Forawi, S. A. (2019). Critical analysis of international STEM education policy themes. Journal of Education and Human Development, 8(2), 82-98. DOI: 10.15640/jehd.v8n2a10

[8]. Amir, K., Mohamed, H. C., & Mnjokava, C. E. (2016). Learners' Attitudes and Performance in Science Subjects in A-Level in Secondary Schools, in Mbarara, Uganda. Journal of Education Research, 2(5), 10-25

[9]. Artemieva, E. (2016). The application of projects methods in training students in secondary vocational education. Olympiáda Techniky Plzeņ, 17(5), 153-155

[10]. Atomatofa, R. O. (2014). Effects of instructional strategies and gender on basic-science students' achievement in Nigeria. Academic Journal of Psychological Studies, 3(3), 207-217

[11]. Bada, A. A. (2021). 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.

[12]. Bakare, O. O. (2017). Teaching and learning I.C.T. as a subject in Nigerian secondary schools: The challenge of pre-service

teachers education preparation. International Journal of Digital Society (IJDS), 8(3), 1316-1323.

[13]. Barry, J. (n.d). Data analysis of pre-post study designs. Cornell statistical consulting unit Retrieved April 24, 2018, from http://www.cscu.cornell.edu.Bassey, I. (2020).Peer Group Influence and Academic Performance of

[14]. Secondary School Students in English Language. Retrieved from https://ssrn.com/abstract=3606183

[15]. Best, J. W., & Kahn, J. V. (1989). Research in education (6th ed.). India: Prentice-Hall.

[16]. Brandenburg, R. (1997). Team wise school of knowledge: An online resource about team Teaching. Retrieved March 15, 2017, from http//www.uwf.edu/coehelp/teachingapproaches/team/.Caine, R.N., & Caine, G. (1990). Understanding a brain-based approach to learning and teaching.Education Leadership, 66-70.

[17]. Connell, J.D. (2009). The global aspects of brained- based learning. Educational Horizons, 28-38.

[18]. Crouch, C. H., & Mazur, E. (2001). Peer instruction: Ten years of experience and results American Journal of Physics, 69(9), 970-977

[19]. De Silvai, A., Khatibi**,** A.,& Azam, S. M. F (2018). What factors affect secondary school students' performance in science in the developing countries? A conceptual model for an exploration. European Journal of Education Studies, 4(6), 80-100.

[20]. Fagen, A. P., Crouch, C.H., & Mazur, E. (2002). Peer instruction: Results from a range of classroom. The Physics Teacher, (40), 206-209.

[21]. Filade, B. A., Bello, A. A., Uwaoma, C. O., Anwanane, B. B., & Nwangburuka, K. (2019).Peer group influence on academic performance of undergraduate students in Babcock University, Ogun State. African Educational Research Journal, 7(2), 81-87

[22]. Gehlen-Baum, V & Weinberger, A. (2014). Teaching, learning and media use in today's Lectures. Computers in Human Behaviour 37(2014) 171–182.

[23]. Gill, P., Stewart, K., Treasure, E. & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. British Dental Journal, 204(6), 291-295. DOI: 10.1038/bdj.2008.192.

[24]. Gok, T. (2014). Peer instruction in the Physics classroom: effects on gender difference performance, conceptual learning, and problem-solving. Journal of Baltic Science Education, 13(6), 776-788

[25]. Gladys, J.U., Stella, D.G., & Omobolanle, G.B. (2018). Effect 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.

[26]. Hamidu, M.Y., Ibrahim, A.I., & Mohammed, A. (2014). The use of laboratory method in teaching secondary school students: a key to improving the quality of education. International Journal of Scientific & Engineering Research, 5(9), 81-86

[27]. Hasni, A., &Potvin P. (2015). Student's interest in science and technology and its relationships with teaching methods, family context and self-efficacy. International Journal of Environmental & Science Education, 2015, 10(3), 337-366

[28]. Herrington, A., Herrington, J., & Glazer, E. (2006). What is an authentic learning environment? In A. Herrington& J. Herrington (Eds.), authentic learning environments in higher education (pp. 1-13). Hershey,PA: I.S.P.

[29]. Hughes, C. E., & Murawski, W. W. (2001). Lessons from another field: Applying co teaching strategies to gifted education. Gifted Child Quarterly, 45, 195-204.

[30]. Inyang, U. S.,& Josiah, M. M. (2016). Students' gender and perceived difficulty of concepts in secondary school physics in Jos metropolis, Nigeria. IOSR Journal of Research & Method in Education (IOSR-JRME), 6(5), 1-5

[31]. Jensen, E. (2014). Jensen learning guide to brain-based teaching. Retrieved July 14, 2018, from http://www.jensenlearning.com/wp-content/uploads/2016/07/10MostEffectiveTips.pdf

[32]. Jensen, E. (2005). Teaching with the brain in mind (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

[33]. Jia, C.,Yang, T., Qian, Y., & Wu, X. (2020). The gender differences in science achievement, interest, habit, and creativity. Science Education International 31(2), 195-202.

[34]. Johnson, R. B., & Christensen, L. (2014). Educational Research: Quantitative, qualitative and mixed approach (5th Ed.). California, U.S.A: SAGE Publications Inc.
[35]. Josiah, M. M. (2012). School location versus academic achievement in physics: Does Computer-Assisted Instruction (C.A.I.) has any effect? Journal of Educational and Social Research, 2(8), 162-168.
[36]. Kaymak, S., Balta, N., Almas, A., Kazmagambet, B., & Mbala, O. (2020). The impact of peer instruction on students' achievement in mathematics analysis. Psychology Research, 10(12), 497-506. doi:10.17265/2159-5542/2020.12.003
[37]. Kirui, J. M., & Kaluyu, V. (2018). Influence of selected psychosocial factors on learners' performance in science subjects: a case of public secondary schools in Moyale sub-county, Kenya. International Journal of Education and Research, 6(1), 15-28
[38]. Kuhn, D., Black, J., Keselman, A., & Kaplan, D. (2000). The development of cognitive skills to Support Inquiry Learning. Cognition and Instruction, 18(4), 495–523
[39]. Leedy, P.D.,& Ormrod, J.E. (2005). Practical research: planning and design (8th ed,).Pearson Educational International and Prentice Hall: New Jersey Legutko, R. S. (2005). The effect of environmental field trips on student learning in middle school. Retrieved March 15, 2017, from https://eric.ed.gov/?id=ED506033
[40]. Limprecht, S., Janko, T., & Gläser-Zikuda, M. (2013). Achievement emotions of boys and girls in physics instruction: Does a portfolio make a difference? OrbisScholae, 7(2) 43−66.
[41]. Löfgren, R., Schoultz,J., Hultman, G., & Björklund, L. (2013). Exploratory talkinscience education: inquiry-based learning and communicative approach in primary school Journal of Baltic Science Education, 12(4), 482-495.
[42]. Main, K., & Brye, F. (2006). What does a "good" team teaching team look like in a middle school classroom? Retrieved March 15, 2017, from http://www98.griffith.edu.au/dspace/bitstream/handle/10072/2538/29483.pdf;sequence=1
[43]. McKee, E., Williamson, V. M., & Ruebush, L. E. (2007). Effects of a demonstration laboratory on student learning. Journal of Science Education and Technology, 16, 395–400. http://doi.org/10.1007/s10956-007-9064-4
[44]. McKim, C. A. (2017). The value of mixed methods research: a mixed methodsstudy. Journal of Mixed Methods Research, 11(2), 202-222
[45]. Mekonnen, S. (2014) Problems challenging the academic performance of physics students in higher governmental institutions in the case of Arbaminch, Wolayita Sodo, Hawassa and Dilla Universities. Natural Science, 6,362-375. http://dx.doi.org/10.4236/ns.2014.65037
[46]. Moore, C. G., Carter, R. E., Nietert, P. J. and Stewart, P. W. (2011), Recommendations for Planning Pilot Studies in Clinical and Translational Research. Clinical and Translational Science, 4(5), 332–337. doi:10.1111/j.1752-8062.2011.00347.x
[47]. Nalevska, G. P., & Kuzmanovska, M. (2020). Teaching methods as a factor of students' learning motivation. Journal of Educational Research 2(3-4), 40-50
[48]. Noureen, G., Awan, R. N., & Fatima, H. (2017). Effect of brain-based learning on academic achievement of VII graders in mathematics effect of brain-based learning on achievement of VII Graders 86. Journal of Elementary Education, 27(2), 85-97
[49]. Omorogbe, E & Ewansiha, J. C. (2013). The challenge of effective science teaching in Nigerian secondary schools. Academic Journal of Interdisciplinary Studies, 2(7), 181-188. Doi:10.5901/ajis.2013.v2n7p181
[50]. Onanuga, P. A & Saka, A. O. (2018). Trend Analysis of Students' Academic Performance in Selected Science, Technology, Engineering, and Mathematics Subjects in Ogun State Basic Education Certificate Examination (OG-BECE), Nigeria, from 2011 to 2015: A Projection for Five Years.Science Education International, 29(2), 110-116.
[51]. Osuolale, O. J. (2014). Problems of teaching and learning science in junior secondary schools in Nasarawa State, Nigeria. Journal of Education and Practice, 5(34), 109-118
[52]. Owen, R.C. (2006). The role of demonstration. In D.M. Matteson & D.K. Freeman (Eds). Assessing and teaching beginning readers: a picture is worth 1000 words (pp.11-26).
[53]. Pallant, J. (2011). SPSS survival manual. A step by step guide to data analysis using SPSS(4thed.). Australia: Allen &Unwin.

[54]. Pattnaik, C., Chakradeo, C.A., & Banerjee, S. (2014). Methods of teaching science. M.A EDUCATION. PAPER-V. Retrieved from http://ddceutkal.ac.in/Syllabus/MA.../Education_Paper_5_SCIENCE.pdf

[55]. Peffer, M.E., Beckler, M.L., Schunn, C., & Recnken, M. (2014). Science classroom inquiry (S.C.I.) simulations: A novel method to scaffold science learning. PLoS O.N.E. 10(3), 1-14. doi:10.1371/journal.pone.0120638.

[56]. Potvin P.,& Hasni, A.(2014). Analysis of the decline in interest towards school science and technology from grades 5 through 11. Journal of Science Education and Technology, 23(2014), 784-802. DOI 10.1007/s10956-014-9512-x

[57]. Prince, A. M. Ed. (2005). Using the principles of brain-based learning in the classroom how to help a child learn. Retrieved July 14, 2018, from https://www.superduperinc.com/handouts/pdf/81_brain.pdf.

[58]. Ramaligela, S.M. (2014). Assessing fourth-year student-teachers' understanding of self-evaluation report writing. Procedia - Social and Behavioural Sciences 116 (2014), 3838 – 3842.

[59]. Ramos, J.L.S., Dolipas, B.B., & Villamor, B.B. (2013). Higher order thinking skills and academic performance in Physics of college students: A regression analysis. International Journal of Innovative Interdisciplinary Research 4, 48-60.

[60]. Rehman, A., & Haider, K. (2013). The impact of motivation on learning of secondary school students in Karachi: an analytical study. Educational Research International, 2(2), 139-147

[61]. Riveros, H.G. (2012). Pleasure as a teaching tool. Latin American Journal of Physics Education, 6(1), 59-62.

[62]. Robinson, B., & Schaible, R. (1995). Collaborative teaching: Reaping the benefits. College Teaching, 43 (2), 57 – 60.

[63]. Schoffstall, A. M., & Gaddis, B. a. (2007). Incorporating guided-inquiry learning into the organic chemistry laboratory. Journal of Chemical Education, 84(5), 848. http://doi.org/10.1021/ed084p848

[64]. Scott, G., Shah, M., Grebennikov, L., & Singh, H. (2008). Improving student retention: AUniversity of Western Sydney case study. Journal of Institutional Research, 14(1), 9–23.

[65]. Sheikh, A, Z. (2020). The role of brain-based learning on the academic performance of students from level 8-11 Inal Jamea Tus-Saifiyah University, Nairobi. IOSR Journal of Humanities and Social Science (IOSR-JHSS), 25(12), 31-43

[66]. Terrell, S. (2011). Mixed-methods research methodologies. The Qualitative Report, 17(1), 254-280. Retrieved from http://www.nova.edu/ssss/QR/QR17-1/terrell.pdf

[67]. Tüfekçi, S., & Demirel, M. (2009). The effect of brain based learning on achievement, retention, attitude and learning process. Procedia - Social and Behavioral Sciences 1(1), 1782-1791

[68]. Turner, D. W., III (2010). Qualitative interview design: A practical guide for novice investigators. The Qualitative Report, 15(3), 754-760.

[69]. Ugo E. A., & Akpoghol, T. V. (2019). Improving science, technology, engineering and mathematics (STEM) programs in secondary schools in Benue state Nigeria: Challenges and prospects. Asian Pacific Journal of Education, Art and Sciences, 3(3), 6-16

[70]. Uwameiye, R., & Ojikutu, R. A. (2008). Effect of team teaching on the academic achievement of students in introductory technology. International Journal of Instruction Technology and Distance Learning, 5(10), 1-14.

[71]. Van Teijlingen, E., & Hundley, V. (2002). The importance of pilot studies. Nurs. Stand 16(40), 33-36.

[72]. Victoria, M.B. (2011). Factors contributing to underachievement of Zambian female students in O-Level Physics examination. A case of selected high schools in central province (Master's thesis). Retrieved from dspace.unza.zm:8080/xmlui/bitstream/handle/123456789/1901...

[73]. Wanbugu, P.W., & Changeiywo, J.M. (2008). Effect of mastery learning approach on secondary school students" Physics achievement. Eurasia Journal of Mathematics, Science & technology education, 4(3), 293-302

[74]. Walker, C.L., Shore, B.M., & French, L.R. (2011). A theoretical context for examining students' preference across ability levels for learning alone or in groups. High Ability Studies, 22(1), 119-141