EFFECT OF BRAINLY ARTIFICIAL INTELLIGENCETECHNIQUE (BAIT) ON IN-SCHOOL ADOLESCENTS' MEMORY DEVELOPMENT AND SELF-EFFICACY IN BASIC SCIENCE

Eze James Sunday, Ekwueme Uchechukwu Hope, Adimora Dorothy Ebere & Umeano Elsie Chizua
Department of Educational Foundations
University of Nigeria, Nsukka

Abstract
The study explored the effect of Brainly Artificial Intelligence Technique on memory development and self-efficacy of in-school adolescents in Basic Science in Obollo-Afor Education Zone of Enugu State. The study adopted quasi-experimental research design specifically non-equivalent control group. The population of the study comprised 2,428 Junior secondary II students (JSS II), from all the government secondary schools in Obollo-Afor Education Zone. A sample of 82 JSS II students was drawn through purposive sampling technique. Two research questions and two null hypotheses guided the study. Two instruments namely: Adolescents' Memory Development Test (AMDT) and Adolescents' Self-Efficacy Questionnaire (ASEQ) were used for data collection. The instruments were face validated by three experts in Measurement and Evaluation. The instruments were subjected to reliability testing using Cronbach Alpha method and reliability indices of 0.82 and 0.88 were obtained for AMDT and ASEQ respectively. Two groups of students were used for the study namely; experimental and control groups. The students in the experimental group were exposed to the use of BAIT in teaching of the selected Basic Science Concepts while the students in the control group were not so exposed. Data collected were analyzed using mean and standard deviation in other to answer the research questions. The null hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The use of BAIT in teaching enhances memory development as well as self-efficacy of in-school adolescents. It was thus recommended that Nigerian education system should incorporate the use of Artificial Intelligence tools such as Brainly into her school curriculum; secondary school teachers should be trained on the development and use of such tools in teaching and learning.

Keywords: Brainly Artificial Intelligence, Memory Development, Self-efficacy, and In-School Adolescents

Introduction

The poor academic achievement of students in Basic Science in Enugu State particularly Igbo-Eze South LGA has been and is still a source of concern to government and parents. It is also area of research interest to educators. The annual release of Junior Basic Certificate Examination results over the years recorded consistent poor academic achievement of students in this important subject. Owing to its prerequisite for science option in further education, many students have developed phobia for the subject, thinking that it is one of the most difficult subjects. However, the study of Basic Science and Technology enables students to apply the skills and knowledge gained through it to solve everyday problems in the environment particularly science learning in school. This landmark can be achieved through the broad themes which encompass all the various components of science being presented to students in a holistic manner (Ukah, 2013). Accordingly, the themes cover knowledge, skills and attitudinal requirement as: you and environment; living and non-living things; you and technology; and you and energy.

The themes are broad outlines and they have sub-topics arranged in a logical sequence for coverage and guide for academic work designed to cover 9-year basic education (Ajayi, 2007). From the numerous topics under the themes, the contents coverage for the present study were limited to three topics: Information and Communication Technology, Crude Oil and Petrochemicals, and Simple Machine and maintenance. The topics align with the trend in the global and national quest to attaining Sustainable Development Goals (SDGs) especially the goal 4 and 9 which emphasized quality education and industry, innovation and infrastructure respectively. Quality education can only be assured when students are allowed access to the global world to interact, learn and use the acquired knowledge to argument the ones acquired from their various classrooms. It could therefore, be said that the study of Basic Science and Technology creates scientific and technological awareness in every child that passes through the 9- year basic education, especially those of the upper basic education.

Several factors have been attributed as the cause of poor performance of students in the subject. For instance, Ajibade, (2007); Adodo and Gbore (2012) identifies poor infrastructure/facilities to the study of the subject in that there are so many students who do not have access to Basic Science and Technology equipment. To this end, Olagunju & Babayemi (2014) identified other problems like: overcrowded classrooms, stereotype method of teaching, poor facilities/equipment and lack of relevant instructional materials. These corroborates with the findings which revealed that teachers' obsolete pedagogies and students' interest contributed much to these problems (Kola

&Olu, 2018. The authors are of the opinion that most science teachers are curriculum-driven and are more interested in finishing the contents of the syllabus as stipulated by the curriculum at the expense of innovation. Observations have also shown that technological divide still exists in most of our schools to this day. Hence, most technology used in some schools are computer labs that classes can schedule times for students use.

With the advent of educational apps, technology is sweeping through classrooms, and learning is made interesting and simple. No more monotonous & tedious blackboard and chalk methods. The e-learning app is all about machine learning and AI-based approach for smarter teaching. There has been a rapid growth in the apps for education and learning. Brainly is added as a recent name in the list and the present study sought to use it to find its effectiveness in teaching students in the Nigerian context. Brainly is a web-based tutoring system which allows students to learn in their own environment whenever it is convenient for them (Degeler, 2014). It can also be seen as a social networking site for classroom instruction delivery, homework help, questions and answers and guide for home and individual academic works and can be used on any device (Petrovich, 2019).Chen, Quadir and Teng (2011) reported that brainly use encourages interactive learning, making students more engaged in their learning activities with the aid of varying computer-based devices. This is to say that the learners can use both their smart phones, laptops and other computer assisted technologies to interact and access information across the brainly community.

Other computer devices notwithstanding, brainly seems to be basically operated with smart phones, thus, its use in education in the words of Spears (2012) can be liken to learning initiative through the "Anytime Anywhere Learning (AAL) program". It is worthy to note that with brainly, most students who are addicted to smart phone and social media will instead use it to enhance their academics, other than social vices that they tend to use it for. Spears (2012) points out the advantages of using brainly to include the addition of combining sound and picture, the interactive opportunities for the learner, the ability to structure one's learning approach, the ability of the system to "remember," the ability to pursue cross-reference, and the increase of the learner's control over the subject matter. This being the case, students in examination class would not have to search for experts that will help them solve most difficult questions, especially in Mathematics.

Application of brainly technique in education requires the teacher to share brainly as an online homework help resource with the students, guide them to create an account or register with brainly website, guide them on how to sign in to the website and appropriate responds on the dialog boxes that will

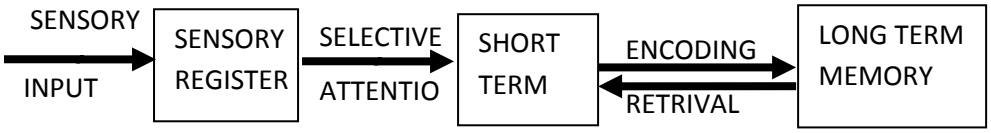
pop up. This was found to help in the creation of powerful learning environments and increase positive interactive experiences for students (High field, 2010). This effective learning approach can be said to increase the quality of learning as students seem to learn best by using the already formed schema to construct new knowledge.

BAIT can be said to function based on the constructivist theory which is hinged on the understanding that the students should be able to use the previous experience to construct new information and knowledge. Thus, the use of BAIT will assist the students to actively process the new information as a result of the storage in the spatial memory system. The students will naturally remember the experience without any rehearsal because it is in the spatial memory system and connect with the new information to be learnt online. It is only through memory capacity that individuals are able to relate to different events, experiences, conditions, people and objects and be able to retain information acquired in the process. Holmes (2012), defined memory as a mental workplace which individuals use for many aspects of their daily life. Put in another form, memory is a remarkable mental process and a mental system which receives information from (external or internal) stimuli, retains it and makes it available on a future occasion (Gladys et al, 2018). In other words, memory process involves the encoding, retention and retrieval of information.

Memory function is a process which begins from the time of receipt of information to the time of recall and usage. Slavin in Fatokun and Adeniji (2015) described memory according to its storage system as long term and short term. Memory also plays a crucial role both in supporting learning and maintaining focused behaviour in the learning environment. Fatokun and Eniayeju (2014) asserted that learning is evident by proper understanding, assimilation and linkage of the new ideas learnt to the existing cognitive structure which promote the retention of such integrated concepts and its recall when required. Based on the features of the human memory system, one may say that memory is a perceptually active mental system. It receives/encodes, modifies, retains/stores and retrieves information (Abiodun & Abiodun, 2014). Encoding refers to the translation of incoming stimulus into a unique neural code that a person's brain can process.

A good and functional memory helps in the processing and storage of information while one is embarking on complex and demanding tasks. It is useful during most routine activities children partake in at schools and homes. *storage* is the retention of the material encoded over a period of time. Suffice it to say that following a set of complex instructions which a child will often have to do in the classroom relies heavily also on the child's ability to

remember the various parts or bites of the instruction while carrying out the numerous steps to complete the actions successfully (Holmes, et al., 2012; Alloway, 2012). R*etrieval* is the recovery of the stored or retained information at a later occasion. The components can be represented thus:



Adopted from General Model of Human Memory System
http://science.howstuffworks.com/environmental/life/human-biology/human-memory.htm

Humans gather information through their senses. Each sensory modality has its own sensory register (or sensory memory). It holds information for a very short duration in the working memory, then it passes the information for further processing to long term memory. What individuals are able to memorize depends to a large extent on what happens to the information once it reaches the sensory memory. Being that individuals are continually bombarded by sensory stimulations of various kinds which they cannot respond to all of them, it is important that they must selectively focus on those things which are significant. This kind of selectivity is possible on the basis of attention. The process of attention limits the input of information which will be received from the environment. Thus, through selective attention information enters short-term memory (STM). STM holds information for a few seconds and transmits it to the long-term memory (LTM) which has a very large capacity to retain information. The information retained will in turn be retrieved from LTM as the need arises otherwise, forgetfulness may set in.

Human is prone to forgetfulness especially when effective learning has not occurred (Johnstone & Otis, 2006). The author maintained that most conditions that affect learning also affect memory. Level of intelligence, motivation, emotional state, environmental factors, significance of the learning object to the learner and method of teaching and learning are some factors that affect a person's memory (Adubasim, 2018). Studies (Fatokun & Adeniji, 2015; Abiodun & Abiodun, 2014; Fatokun & Eniayeju, 2014) have shown numerous strategies for memory improvement since the brain serves as the center for assimilation, coordination, retention and reproduction of information which is often linked with the learning situation and this is consequently a vital determinant of achievement in science learning.

Findings from studies conducted on students' cognitive development revealed that a large proportion of secondary school students operate below the formal operational level of thought (Cephni, Ozsevgec & Cerrah, 2004; Ozoji, 2014). Other research findings (Gathercole, Lamont & Alloway, 2006; Gathercole & Alloway, 2008; Gathercole & Alloway, 2007) show that the majority of students with memory deficit or difficulty present poor academic achievement and progress, failure to complete common classroom activities that require multiple instructions or information to bear in mind, easily distracted, inability to keep their place in demanding and complex activities such as writing, difficulty with multi step instructions.

People retain more of the activities they participated actively than the ones they less participated. Hence the use of technology enhanced devices in learning helps to concretize the learning process. What a student sees with his or her eyes is easily registered and fastened to the brain than what he or she heard. The use of technology in learning seem to have provided a very quick modality of learning to learners, unlike in the past years that everything depended on what the teachers give in the classrooms. Students can easily learn or acquire information through manipulation of technology-based gadgets and websites. Hence, good education for students today is on how to use technology to learn, communicate and work with ideas. For instance, a student who plays puzzle game and other brain tasking games using computers tends to think and reason faster, and keep the brain at alert compare to his counterpart who do not have such access. In like manner, students who use BAIT to enhance their classroom learning will tend to demonstrate more memory retention than those who are not opportune to use it. The relationship between BAIT and memory development is that an individual whose memory is well developed, will tend to think faster, reason correctly and this enables such individual to engage in academic tasks. We therefore, sought for the mean memory development of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement.

Enhanced memory could have direct effect on students' academic self-efficacy. Self-efficacy means one's confidence to carry out a particular task or functions successfully. Academic self-efficacy refers an individual's belief (conviction) that he can successfully achieve a designated level on academic task or attain a specific academic goal (Eccels & Wigfield, 2002; Linnenbrink, & Pintrich, 2002a). Research suggests that having high self-efficacy when attempting difficult tasks creates feelings of calmness or serenity (Campbell, 2007). Many researchers have attempted to relate self-efficacy to different educational, social, and psychological factors such as the strategies of learning (Bembenutty**,** 2007), motivational constructs such as persistence and

goals/goal setting (Chemers, Hu, & Garcia, 2001), affective constructs such as stress and anxiety (Chemers, Hu, & Garcia, 2001; Finney & Schraw, 2003; Zajacova et al., 2005), academic achievement (Adeyemo, 2007; Bembenutty**,** 2007). These researchers have reported that students with higher levels of self-efficacy tend to be more self-regulated and persistent in their learning, more motivated to learn and to be successful in their learning, experience less stress and anxiety, and as a consequence have higher academic achievement than their counterparts who are low in academic self-efficacy.

In relation to use of BAIT, the researchers observed that the present-day adolescents have high passion for technological devices such as smart-phones, computers, and televisions among others, hence will tend to be excited when they are allowed to use smart phones and computers to enhance learning (Downey, Eccles & Chatman, 2005). This will tend to boost their self-efficacy and encourage them to be consistent in the use of the technology. On this note, we sought to find the mean academic self-efficacy of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement.

Research Questions

1. What is the mean memory development of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement?
2. What is the mean academic self-efficacy of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement?

Research Hypotheses

The following null hypotheses were formulated to guide the study and they were tested at 0.05 level of significance

Ho_1: There is no significant different in the mean memory development score of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement

Ho_2: There is no significant difference in the mean academic self-efficacy of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement

Method

The design of the study is Quasi-experimental research design of non-equivalent control group. The population of the study comprised of 966 Junior Secondary School Two students (JSS II) in Igbo-Eze South Local

Government Area of Enugu State, in 2018/2019 academic session (Planning Research and Statistics PRS Obollo-Afor Education Zone). The choice of JSS II students for the study is because they were in their penultimate class and were neither adjusting to Upper Basic Science Syllabus as JSS I students were doing nor were they preparing for external examination as JSS III students are doing. The population of the study comprised of 966 Junior Secondary School Two students (JSS II) in Igbo-Eze South local government area of Enugu State, Nigeria. A sample of 82 JSS II students drawn from two intact classes were used for the study. The use of intact class was to avoid threat of selection bias among the students and to avoid re-arranging and re-grouping which could disrupt the normal lessons. Two research questions were posed and two null hypotheses were formulated and tested at 0.05 level of significance. Instrument used for data collection was Basic Science Memory Development Test (BCMDT) and Basic Science Academic Self-Efficacy Scale (BCASES). The instrument was validated by one specialist in Science Education and two from Educational Psychology. The internal consistency estimate of the instrument was determined using Cronbach Alpha method and the reliability coefficients of 0.82 and 0.88 were obtained for BCMDT and BCASES respectively. All the research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Experimental Procedure

The researchers sought for the co-operation of the principals and teachers of the schools used to enable them conduct the research in their schools. The regular teachers were allowed teach the selected topics with their normal lesson plans for both control and experimental classes. The teachings of the subjects in both experimental and control groups were held for 40 minutes per day during normal school timetable schedule for six weeks. The regular teachers were allowed to teach both groups to take care of hawthorn effect which might result when the students are aware that they are engaged in an experiment.

The researchers used prepared brainly lesson plan to provide further instruction, clarification, citing of examples, asking questions and providing response to questions to students in experimental group in the form of homework exercise. Other Brainy communities across the globe were not restricted from contributing to the topic under study. The researchers ensured that all the students in the experimental group had smart phone which they used during the period of the experiment. The researchers downloaded Brainly website and installed it on the various smartphones that were used for the

study, created brainy account for the students, taught them how to log in using their accounts and finally direct the students on the use of brainy. The online exercise lasted for 6 weeks as the normal teachings and subjects were allowed to access the program as much as they can. At the end of the experiment, the researchers with the help of subject teacher administered the posttest to the students in the general classroom under a uniform testing atmosphere. The results were collated and subjected for analysis to answer the research questions and to test the null hypotheses.

RESULTS

Research Question 1:

Table 1: Pretest and Post-test Mean of memory development of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement

Groups		**Pretest**			**Posttest**		
		N	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Difference**
Experimental (BAIT)	Group	37	41.92	5.56	62.14	6.16	20.22
Control (Without BAIT)	Group	45	38.91	7.29	46.93	5.50	8.02

Result on Table 1 shows the pretest and posttest mean memory development of students whose Basic Science teachings were enhanced with BAIT and those without BAIT enhancement. Result shows that the students whose teachings were enhanced with BAIT had mean memory development score of ($\bar{x}$ = 41.92, SD = 5.56) at the pretest and mean memory development score of ($\bar{x}$ = 62.14, SD = 6.16) at the posttest, while those whose teaching of Basic Science were not enhanced with BAIT had memory development score of ($\bar{x}$ = 38.91, SD = 7.29) at pretest and mean memory development score of ($\bar{x}$ = 46.93, SD = 5.50) at posttest. Mean difference of 20.22 and 8.02 for the experimental and control groups respectively imply that the use of BAIT had positive effect on the mean memory development of students in Basic Science more than the control group.

Hypothesis One

Table 2: Analysis of Covariance (ANCOVA) of the Effect of BAIT on Memory Development of Students in Basic Science

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	4919.668[a]	2	2459.834	78.554	0.00	0.66	
Intercept	4020.824	1	4020.824	128.403	0.00	0.61	
Pretest MDT	227.316	1	227.316	7.259	0.01	0.08	
Group	4014.626	1	4014.626	128.205	0.00	0.61	S
Error	2473.808	79	31.314				
Total	244673.000	82					
Corrected Total	7393.476	81					

Note: S = Significant, η^2_p = partial eta squared

The result on Table 2 shows the effect of BAIT on memory development of students in Basic Science. The result shows that the effect of BAIT on memory development of students in Basic Science was significant ($F(1, 81) = 128.205$, $p < 0.05$, $\eta^2_p = 0.61$). Since the associated probability value of 0.00 is less than 0.05 set as level of significance, the null hypothesis which states that there is no significant different in the mean memory development score of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement is rejected. Thus, inference drawn is that there is a significant different in the mean memory development score of students whose Basic Science teaching was enhanced with BAIT than those without BAIT enhancement. The result further showed the effect size ($\eta^2_p = .61$), which indicate that 61 percent variance in students' memory development is explained by BAIT.

Research Question 2:

Table 3: Pretest and Post-test Mean academic self-efficacy students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement.

Groups	**Pretest**			**Posttest**		
	N	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Difference**
Experimental Group (BAIT)	37	54.16	6.61	63.68	6.52	9.52
Control Group (Without BAIT)	45	45.00	8.17	52.36	8.39	7.36

Result on Table 3 shows the pretest and posttest mean academic self-efficacy of students whose Basic Science teachings were enhanced with BAIT and those without BAIT enhancement. Result shows that the students whose teachings were enhanced with BAIT had mean academic self-efficacy score of ($\bar{x}$ = 54.16, SD = 6.61) at the pretest and mean academic self-efficacy score of ($\bar{x}$ = 63.68, SD = 6.52) at the posttest, while those without BAIT enhancement had academic self-efficacy score of ($\bar{x}$ = 45.00, SD = 8.17) at pretest and mean academic self-efficacy score of ($\bar{x}$ = 52.36, SD = 8.39) at posttest. Mean difference of 9.52 and 7.36 for the experimental and control groups respectively imply that the use of BAIT had slight positive effect on the mean academic self-efficacy of students in Basic Science more than the control group.

Hypothesis Two

Table 4: Analysis of Covariance (ANCOVA) of the Effect of BAIT on Students' Academic Self-Efficacy in Basic Science

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	2917.417[a]	2	1458.708	26.682	0.00	0.40	
Intercept	3626.575	1	3626.575	66.335	0.00	0.45	
Pretest SE	315.446	1	315.446	5.770	0.01	0.06	
Group	1167.708	1	1167.708	21.359	0.00	0.21	S
Error	4318.974	79	54.671				
Total	278004.000	82					
Corrected Total	7236.390	81					

Note: S = Significant, η^2_p = partial eta squared

The result on Table 4 shows the effect of BAIT on academic self-efficacy of students in basic science. The result shows that the effect of BAIT on academic self-efficacy of students in Basic Science was significant ($F(1, 81) = 21.359$, $p < 0.05$, $\eta^2_p = 0.21$). Since the associated probability value of 0.00 is less than 0.05 set as level of significance, the null hypothesis which states that there is no significant difference in the mean academic self-efficacy of students whose Basic Science teaching was enhanced with BAIT and those without BAIT enhancement is rejected. Thus, inference drawn is that there is a significant difference in the mean academic self-efficacy of students whose Basic Science teaching was enhanced with BAIT than those taught without. The result further showed the effect size ($\eta^2_p = 0.21$), which indicate that 21 percent variance in students' academic self-efficacy is explained by BAIT.

Discussion of Findings

The findings revealed that the use of BAIT had positive effect on the mean memory development of students in Basic Science. This is confirmed by a further test of hypothesis which revealed a significant difference in the mean memory development score of students whose Basic Science teaching was enhanced with BAIT than those without BAIT enhancement. Also, a further measure of effect size (estimation) of BAIT using partial eta squared (η_p^2) showed that the use of BAIT accounted for the higher increase observed in memory development of JSS II students used in the experiment.

Increase in memory development will make for increase in mental imagery, thinking, reasoning and problem-solving needed for students to perform excellently in a positive emotional state. The finding is consistent with the study which found that that learning is evident by proper understanding, assimilation and linkage of the new ideas learnt to the existing cognitive structure which promote the retention of such integrated concepts and its recall when required (Fatokun & Eniayeju, 2014). It also, aligns with the findings of Taylor (2012) which states that frequent exposure of students to technology use is actually wiring the brains to perform in different ways towards attaining mental excellence. In the online interaction, students are made to develop deeper schema construction following their prior experience in the class. Fatokun and Fatokun (2012) posited that learning of difficult mathematical concepts can be enhanced through metacognitive strategies of learning which is based on constructivist theory as this affords the learners the consciousness of their own cognitive processes as learning progresses.

Furthermore, the finding revealed that the use of BAIT had positive effect on the mean academic self-efficacy of students in Basic Science. A further test of hypothesis revealed a significant difference in the mean academic self-efficacy score of students whose Basic Science teaching was enhanced with BAIT than those without BAIT enhancement. The use increase in self-efficacy could be traced to the prompt response they received during online interaction in the course of the experiment which has helped to calm their anxiety and inquisitiveness towards learning. Study by Campbell (2007) is of the view that having high self-efficacy when attempting difficult tasks creates feelings of calmness or serenity. The finding is in consistent with the findings which revealed that individual's belief (conviction) will help them to successfully achieve a designated level on academic task or attain a specific academic goal Eccels & Wigfield, 2002; Linnenbrink, & Pintrich, 2002a)

Conclusion

The use of BAIT in IN enhancing students' memory development and academic self-efficacy in the subject. This conclusion is based on the findings of this study which revealed significant difference in mean memory development and academic self-efficacy of students whose Basic Science teachings were enhanced with BAIT and those without BAIT enhancement.

Recommendations

Federal government through the Ministry of Education should organize conferences, seminars and in-services training for Basic Science teachers for them to learn the application of the strategy for its efficient use in classroom instructional delivery. This will help to acquaint Basic Science teachers with the distinctive support of the strategy with a view to adopting and using it in the class.

References

Abiodun, S. &Abiodun, M. (2014) *Human Learning – students' Edition*, (2nd ed), Lagos: Mafabi Publishers

Adeyemo, P. A (2007). *Principles and practice of education:* University of Ile-Ife.

Adodo, S.O. &Gbore. L. O. (2012). Prediction of attitude and interest of science students of different ability on their academic performance in basic science. *International Journal of Psychology and Counseling*. 4(6), 68-72. Retrieved from ttp://www.academicjournals.org/IJPC

Adubasim, I. (2018). Improving working memory and processing speed of students with dyslexia in Nigeria. *Journal of Education and Entrepreneurship.* 5 (2), 103-124. **https://doi.org/10.26762/jee.2018.40000017**

Ajayi, M.A. (2007). *Effect of learning environment on students' academic achievement in Lagos State secondary schools*. Unpublished MED thesis University of Nigeria.

Alloway, T.P. (2012). Commentary on the profile of executive function of very preterm children at 4 to 12 years. *Developmental Medicine & Child Neurology, 54*, 203-204.

Bembenutty, H. (2007). Self- regulation of learning and academic delay of gratification: Gender and ethnic differences among college students. *Journal of Advanced Academics, 18*(4), 586–616.

Campbell, M. M. (2007). Motivational systems theory and the academic performance of college
students. *Journal of College Teaching & Learning, 4*(7), 11-24.

Cephni, S. Ozsevgec, T &Cerrah, L. (2004). Turkish middle school students' cognitive developmental levels in science. Asia – Pacific Forum on Science Learning and Teaching, 5(1), 1-22.

Chemers, M.M., Hu L.T., & Garcia, B.F (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational Psychology*, 93(1):55-64.

Chen, N. S., Quadir, B., &Teng, D. C. (2011). A Novel approach of learning English with robot for elementary school students. In M. Chang et al. (Eds.), Edutainment 2011, LNCS 6872 (pp. 309-316). Heidelberg, Germany: Springer-Verlag Berlin Heidelberg.

Degeler, A. (March 17, 2014). Crowd sourced School Homework: Brainly Plans to Teach the US. The Next Web

Downey, G, J. Eccles, s. & Chatman, C (2005). Navigating the future: social identity, coping, and life tasks.New York: Russell Sage. 2005.

Eccels, J.S. &Wigfield, A.W. (2002). Motivational beliefs, values, and goals. Annual Review of Psychology, 53 (1), DOI: 10.1146/annurev.psych.53.100901.135153

Fatokun K.V.F &Adeniji, K.A. (2015). Investigating students' learning styles and memory improvement strategies for effective learning of mathematics and science at tertiary level.*European Journal of Research and Reflection in Educational Sciences, 3(5), 28-35.*

Fatokun, K. V. & Eniayeju P. A. (2014a) The effect of Concept Mapping-Guided Discovery Integrated Teaching Approach on chemistry students' learning style and achievement in Electrolysis. *FUDMA Journal of Science and Educational Research (FJSER)* Vol. 1 (2) 18 - 32

Fatokun, K. V. F. (2012). The Effect of Concept Mapping-Guided Discovery Integrated Teaching Approach on Chemistry Students' Learning Style, Achievement and Retention. Unpublished Ph.D Thesis Nasarawa State University, Keffi.

Finney, S. J., & Schraw, G. (2003). Self-efficacy beliefs in college statistics courses. *Contemporary Educational Psychology, 28,* 161-186.

Gathercole, S. E. &Alloway, T. P. (2007). *Understanding working memory:* a classroom guide. Harcourt Assessment, Procler house, 1Procler street, London WCiv 6EU Sage Publications.

Gathercole, S. E., &Alloway, T. P. (2008). *Working memory and learning: A practical guide for teachers*. London, UK: Sage Publishing.

Gathercole, S.E., Lamont, E., &Alloway, T.P. (2006). Working memory in the class-room. In S. Pickering & G. Phye (Eds.), Working memory and education (pp. 219–240). San Diego, CA: Academic Press.

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.*

Highfield, K. (2010). Robotic toys as a catalyst for mathematical problem solving. Australian Primary Mathematics Classroom, 15(2), 22-27.

Holmes. J. (2012). Working Memory and Learning Difficulties. *Dyslexia Review. Retrieved from http://www.mrc-cbu.cam.ac.uk/wp-content/uploads/2013/09/Working-memoryand-learning-diffculties.pdf.*

Holmes J., Gathercole, S.E., Place, M., Hilton, K.A., Dunning, D.L., Hilton, K.A. and Elliot,

J.G. (2012). Working memory deficits can be overcomes: Impacts of training and medication on working memory in children with ADHD. *Applied Cognitive Psychology, 24*, 827-836.

Kola, A.J. &Olu, A.M. (2018).The Application of Brain-Based Learning Paradigm in Science Education, Nigeria: A Review. *Journal of Scientific and Engineering Research*, 5(7), 325-331. *Available online www.jsaer.com*

Linnenbrink, E. A., &Pintrich, P. R. (2003). The role of self-efficacy beliefs in student engagement and learning in the classroom. *Reading & Writing Quarterly, 19*, 119-137.

Olagunju, A.M. &Babayemi, J.O. (2014). Effects of enhanced explicit teaching (explicit teaching + peer-tutoring) strategy and gender on students' attitude to Basic Science. *Journal of Education and Leadership Development*. 6(2), 135– 150.

Ozoji, B.E. (2014). Effects of concept mapping technique on students' cognitive development in Nigeria: Implications for science and technology instruction. Stemplanet 1 (1), 1-10.

Petrovich, Liesha. "With 80 Million Users, Poland-based Brainly is Changing Education". HuffPost. The Huffington Post Media Group. Retrieved 31 January 2019.

Planning, Research and Statistics (PRS) Unit, (2018). *Consolidated list of schools and JBCE results.* Post Primary Schools Management Board Zonal Office Obollo-Afor.

Spears, S. A. (2012). Technology-enhanced learning: The effects of 1:1 technology on student performance and motivation (Doctoral thesis). University of West Florida.

Ukah, V.I. (2013). Implementing basic science and technology curriculum: the use of outdoor education in Afikpo education zone of Ebonyi State. *Proceedings of the 54th Annual Conference of Science Teachers Association of Nigeria.* 182-191

Zajacova, A., Lynch, S. M. & Espenshade, T. J. (2005). Self-efficacy, stress and academic success in college. *Research in Higher Education, 46*(6), 677-705.