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Personalized Learning and Achievement in Basic Science: An Experimental Report

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Abstract

The importance of Science to national development cannot be disputed. That is why Basic Science is taught as a foundational science subject in the Junior Secondary Schools in Nigeria. It is meant to inculcate basic scientific knowledge and skills in students. However, the subject, in which students' performance is low, has also not enjoyed a plethora of Information and Communication Technology (ICT) tools to support its learning. Given these challenges, an investigation of the effect of personalized strategy on achievement in Basic Science was carried out. The study employed the pretest, posttest group, quasi-experimental design. The sample comprised of intact classes of year three (JSS 3) Basic Science students (87) from two junior secondary schools in Ijebu-Ode Local Government Area. Using the Balloting method, the students were assigned experimental and control groups. Two stimulus instruments (Teachers' Conventional Teaching Guide (TCTG) and Teachers' Instructional Guide on Personalized Learning (TIGPL), and, response instrument (Basic Science Knowledge Assessment Scale (BSKAS) (r = 0.78), were used for data collection. The four hypotheses raised were tested using t-test at 0.05 level of significance, to compare performances. The results show significant mean differences in the performance scores of the experimental and control groups. This was in favour of the experimental group who were instructed using personalised strategy. Based on this, more efficient ICT-based personalised packages need to be developed for students to aid their understanding and learning of Basic Science.

Keywords: Effect, personalized learning, basic science, junior secondary school.

INTRODUCTION

Science is an organized body of knowledge in the form of concepts, laws, theories and generalizations. It is the study of nature and natural phenomena in order to discover their principles and laws [1]. The influence of scientific knowledge on global development cannot be overemphasized. Nations that prioritize science and technology education such as America, China, Japan and the few others are at the forefront of scientific and technological development in the world today. The teaching and learning of Science in schools develop students' ability to think critically and also helps in developing their abilities to perceive, formulate and solve problems [2]. Thus, the knowledge students acquire from the teaching and learning of science is foundational for developing their nations socioeconomically [3]. Given this, the knowledge which the learning of science and technology education makes available to students need be taken as a priority and should also take a special place in the curriculum in view of national needs and realities. Interrelated, there

are three aspects of Science. These are content (physical, life and earth sciences); process, (inquiring skills such observing, classifying, experimenting, measuring, inferring and organizing, among others), and attitude (openness and objectivities) [4]. Thus, science learning is designed to guide the world toward a scientifically literate society [5]. The Nigerian Government realizes the importance of science teaching and learning and therefore, through its Educational Policy stresses the need for scientific and technological education to be acquired by citizens [6]. In view of these, science is taught at the primary, junior and senior secondary education levels in Nigeria. Basic Science is one out of four other science subjects taught at the junior school and it is a compulsory subject.

Basic Science and Technology is a subject made up of Basic Science, Basic Technology, Physical & Health Education and Computer Studies. It is a subject which prepares students for a solid foundation in Science. Some of the objectives of teaching Basic Science in the junior schools include the inculcation of basic field and laboratory skills in students; inculcation of skills for the application of scientific knowledge in day-to-day living as well as functional skills for scientific attitudes [7]. Solid foundation in this subject at the junior school is preparatory for taking and excelling in subjects like Biology, Physics and Chemistry at the senior secondary schools and beyond, which are in turn needed for qualifying for and studying science and technology-based courses at the University. This foundational knowledge of Basic Science and Technology remains a strong requirement for the study of life sciences including biotechnology, anatomy, microbiology, physiology, and medicine, among others, all of which are germane to man's existence [8].

However, despite the relevance attached to the teaching and learning of Basic Science in junior schools, it has been observed that the face-to-face or conventional teaching method has not been effective in conveying the knowledge required of the subject to students effectively. The attendant poor performance of students in the subject and their shallow knowledge show the need for an urgent step to be taken to salvage the situation. The conventional or traditional method of teaching has been fingered in this poor situation. The intent to find out the causes of poor achievement of students in science has lingered for long [9] but having examined some other factors that affect students' performance in science, including gender, socioeconomic status, school environmental factors, student's cognitive styles, teaching methods, students' lack of interest in science and other challenges and how they affect students' achievement, there exists no evidences that authors have examined the effect of personalised tutoring on performance in Basic Science in junior secondary schools [10, 11, 12, 13].

Also, the Covid-19 pandemic has changed the way teachers teach and the way students learn. This is because as the pandemic still rages, guaranteeing that teachers will continue to physically be with their students on the long run may not be feasible, at last to some extents. In addition to this, the clamour for knowledgeable societies and knowledge-based economy of the 21st century has set a new stage training and education in general. Therefore, the need for learners to acquire the right mix of knowledge and skills are increasingly becoming relevant both for the economic strength, scientific and technological developments cum a socially cohesive society, all of which are germane for the quality living of all citizens. This important objective may not be achieved using the traditional/conventional method of teaching. This is because the conventional strategy of teaching and learning of Basic Science and Technology primarily revolves around a teacher-centered approach. This approach promotes rote learning, making students not to have deeper knowledge required for scientific and technological development of their nation. Consequently, teachers' works become conveying information, assigning work, and leaving students to master contents on their own [14]. Due to the importance attached to science in the 21st Century, it becomes necessary to seek for novel ways of assisting the "millennials" learn effectively using modern approaches so that the scientists of tomorrow are not impeded by the faulty teaching methods of today. One of such active and concrete instructional methods is personalized learning.

Personalized Learning and its Components

[15] stated that personalized tutoring or learning involves setting up individually tailored learning in relation to each student's interest and needs. This, as a method assists in improving flexibility which in turn supports content mastery, thereby enabling students to be in charge of when, where, what and how they learn. [16] stated that when learning is personalized, it means that learning is customized to individual students' needs and objectives; their current knowledge, and; their choice of learning styles. It is an updated version of Computer-Assisted Instruction (CAI) are meant to guide students in a set of learning activities in relation to their performances. Information and Communication Technologies (ICTs) have dominated almost every

sphere of human endeavour, and the educational sector is not excluded. The Department for Education and Skills (DfES) (2006), cited by [17], proposed that "personalized learning has five components" as shown in Figure 1. According to the Department for Education and Skills (DfES) (2006), "the utilization of Information & Communication Technologies (ICTs) cut across these key components, thereby bringing about creativity, prolonging instructional opportunities, and sustains diverse challenging rates of learning".

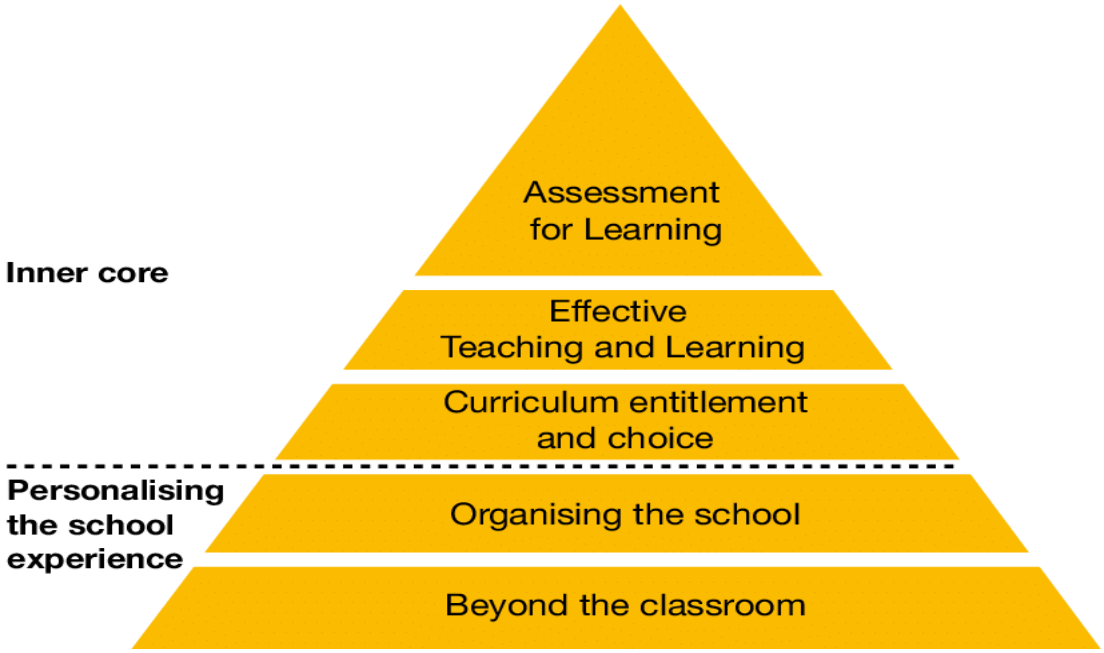

Figure 1: Components of personalised learning
Source: [34]

"Assessment for learning", according to the Department for Education and Skills (DfES) (2006), "is required to drive individual's achievement with sustained feedbacks from and for learners". "Effective teaching and learning focuses on the development of teaching skills for teachers and effective learning skills for capacity for learners to carry on learning on their own". On the other hand, "flexible curriculum is a mix of the core curriculum, qualitative opportunities to expand learning experience supports from school which assists learners to make decisions in relation to their assessment results, among others". "Organizing the school requires educational leaders and educators to creatively think about school organization", and finally, the last component, "beyond the classroom means giving due guidance and supports to individual learners for effective care.

Importantly, the landscape of education is changing at the speed of light. What was formally the norm, that is, face-to-face classroom teaching and learning activities is now fading gradually as the incorporation of ICT in education is paving the way for modern strategies. The introduction of Information and Communication Technologies in education has fast forwarded educational activities to the extent that the normal conventional classroom teaching and learning activities is not enough anymore to take care of the learning needs of the present students. According to [18], students of this Century who are being referred to as digital natives or millennials, grow up using technology at an early age which was not the normal situation many years back. Therefore, they learn differently from those before them because technology and modern strategies have become a way of life for them. They have information at their fingertips due to the Internet and other ICT gadgets readily available to them [14]. In addition, students' learning is now done from anywhere and anytime from the comfort of their homes while their teachers may be thousands of miles away from the classroom where many believed learning is supposed to take place. This form of learning has been aided and made possible through the application and use of Information and Communication Technology (ICT). Hence, the incorporation of technologies in addition to modern teaching methods have revolutionized the ways teachers teach and the way students learn [8]. In view of this, the study tested the following hypotheses:

HO1: There is no significant mean difference in the pre-test scores of the experimental and control groups.
HO2: There is no significant mean difference in the post-test scores of the experimental and control groups.
HO3: There is no significant mean difference in the pre and post-test scores of the control group.
HO4: There is no significant mean difference in the pre and post-test scores of the experimental group.

LITERATURE REVIEW

Personalized Learning and Students' Achievement

The utilization of Information and Communication Technology (ICT) tools to individualize learning for students has been around for long. Earlier, Skinner's (1958) experiment demonstrated the effect of teaching machines in assisting students' learning and independence which further allowed students' independent tasks' completion, and at their own rate. This demonstration established the wherewithal on the use of technology in supporting instructional [19]. [20], cited in [21], stated that recent works in this aspect of learning have focused on adaptive and dynamic implementations which is sometimes referred to as personalized learning systems. Several reports abound on the gains of personalizing learning for students and of such is the fact that personalized learning has the potential of revolutionizing the education system [22, 21]. Within this context, personalised learning as a concept increasingly advocates that learning should not be time, barrier and place restricted, and must be continuously tailored and modified to individual student's needs; their abilities, knowledge status, and interests among others. This method therefore implies a radical departure from traditional method of instruction to a personalised learning situation.

According to [23], in order for meaningful instruction to take place, there is the need for a suitable channel of content presentation to students. Therefore, a sound knowledge of the principles of pedagogical effectiveness in science teaching and learning, which include knowledge of students' psychology, science contents mastery, knowledge of instructional methods, conducive environment for learning, among others are need. [24] reported that the use of conventional method in teaching science is only useful in introducing topics to students since the method assists in promoting initial understanding of science principles and concepts. For this method to be useful, however, requires being use along with other instructional strategies including pairing, role play, group work, and modern personalised learning approaches. In view of this, [25] reported that the utilization of ICT in instructions cannot be overemphasized just as [26] reported that using ICT tools in instruction is an important consideration and inclusion in instructions. Hence, ICT-based personalized approach to learning, which is a form of CAI, is interactive and involves the use of software to present instructional content to students, while also monitoring their learning using a combination of graphical media, sounds, videos, and texts, among other useful media tools in the learning processes.

Personalized learning is one of the strategies that promote active learning. [27], cited by [28] stated that "active learning is an instructional activity which involves learners doing certain activities and thinking about what they are doing". Instructional strategies such as personalized learning that aims at promoting focus-based learning strongly focus on the development of learners' skills as against mere transmission of contents which is not farfetched from the traditional methods. In essence, active or focus-based learning promotes learners' efforts to actively construct knowledge. For instance, [29, 30, 31, 32] in [28], have all reported that "the inculcation of the active learning methods in instruction help to bring about improvement in students' outcomes. Also, [33] found that learners under traditional instructions were 1.5 times more likely to fail compared with learners under non-active instructional strategies. This is represented graphically in Figure 2.

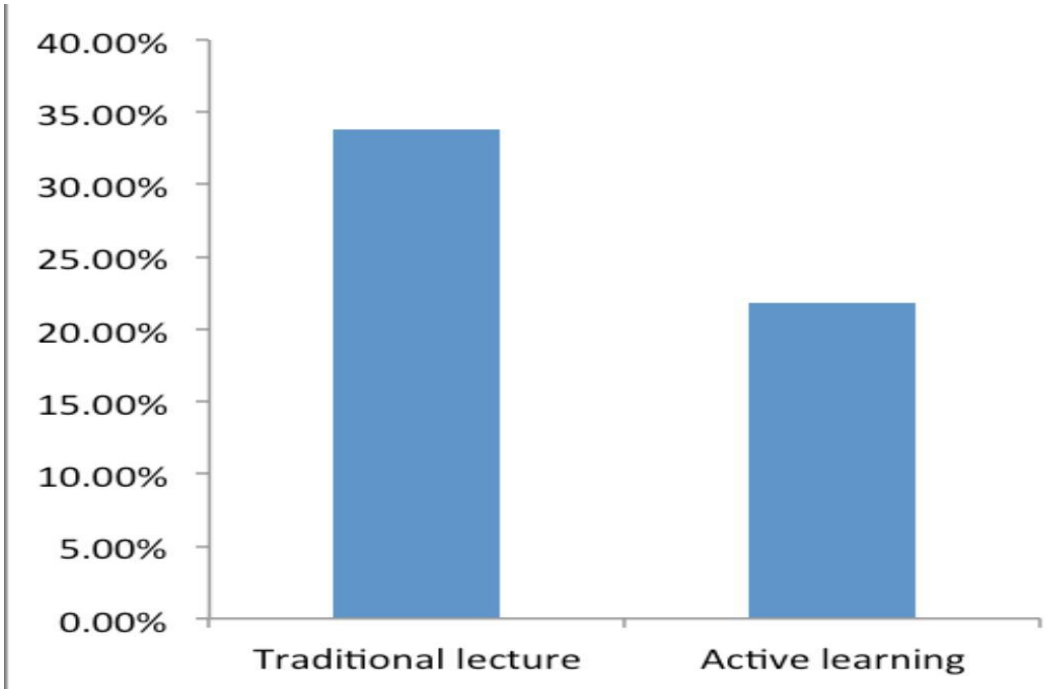

Figure 2: Probability of failure
Source: [33] in [28]

MATERIALS AND METHODS

Research Design, Sample and Population

The study employed the pretest, posttest group quasi-experimental design. There was no randomization of participants into treatment groups. The sample was made up of an intact class of 87 junior secondary school students (JSS 3) in Ijebu–Ode Local Government Area, Ogun State. Using the simple random sampling technique, two (2) junior secondary schools were selected to which treatment conditions (experimental and control groups) were later assigned. Treatment conditions were assigned using balloting method which was a confidential way of assigning the schools to treatment conditions without bias.

Measured Instruments

One response and two stimulus instruments were used for data collection in the study. Two categories of stimulus instruments were used namely;

i. Teachers' Conventional Teaching Guide (TCTG). This was developed by the researchers and used to teach the control group using conventional teaching method. It is was a form of lesson note to guide the teacher.
ii. Teachers' Instructional Guide on Personalized Learning (TIGPL). This was developed by the researchers and used to facilitate the experimental group in using the personalized learning mode.

The response instrument was also developed by the researchers and administered on the experimental and control groups. The instrument was titled Basic Science Knowledge Assessment Scale (BSKAS). It tested students' knowledge pre and post in the study. The instrument was developed to cover topics in sense organs since all the topics in the curriculum on Basic Science and Technology could not be used at once. It contained thirty (30) dichotomous response items.

Reliability of the Instrument

The reliability of the BSKAS was done using Kuder Richardson 21. In this case, twenty (20) copies of the instrument were randomly administered on JSS 3 learners outside the study sample to avoid bias. The analysis of the data collected data showed a coefficient of 0.78, which showed that the instrument was reliable.

Experimental Stages

Pre-test: This is the initial stage of the experiment. In this stage, pretest administration on both the experimental and control groups was carried. The pretest instrument, Basic Science Knowledge Assessment Scale (BSKAS) was administered on both groups to ascertain their knowledge of the subject matter. The duration took few days, inclusive of administration and recollection in the two schools. After this stage, the strategies for each group was administered as outlined below:

i. *Treatment Package for the Experimental Group (TPEG)*: This section involves giving trainings to the experimental group on the usage of the personalised package adopted in the study. Their observations and questions based on the usage of the product were attended to in order to avoid any problem during the use of the package. Thereafter, students were allowed to personally interact with the package for some weeks. This stage lasted for three weeks. The personalized approach was used on the experimental group only. The students were guided by their Basic Science to avoid bias and unnecessary interference with data collection.

ii. *Conventional Package for the Control Group (CPCG):* This stage involves the application of the conventional teaching method on the control group. The stage made use of the Teachers' Conventional Teaching Guide (TCTG). Students were taught sense organs using the conventional teaching method. The use of the conventional teaching lasted for three weeks as well. The students were taught by their Basic Science teacher who didn't let them know it was a study to avoid bias and unnecessary interference with data collection.

Post-test: The Basic Science Knowledge Assessment Scale (BSKAS) was re-administered to the experimental and control groups in order to collect data on their performances for comparison with their pretest scores after the experiments. The study lasted for 6 months.

Method of Data Analysis

The hypotheses raised in the study were tested using t-test at 0.05 alpha level of significance.

RESULTS AND DISCUSSION

H_O1: There is no significant mean difference in the pre-test scores of the experimental and control groups.

Table 1: Mean differences in pre-test scores of the groups

Variables	N	Mean	Std.dev	't'	p-value	df
Experimental group (pretest)	52	37.19	3.33			
Control group (pretest)	35	36.50	3.79	-2.89	0.05	86

Table 1, shows a mean score of 37.19 for experimental group and 36.50 for control group respectively. Based on t-value ($t > 1.96$) and p ($p<0.05$) in the table, there is a significant difference between experimental and control group. Rework. This implies that experimental cohorts performed better than control group. Also, effect this under discussion section.

H_O2: There is no significant mean difference in the post-test scores of the experimental and control groups.

Table 2: Mean differences in post-test scores of the groups

Variables	N	Mean	Std.dev	't'	p-value	df
Experimental group (posttest)	52	39.19	3.25			
Control group (posttest)	35	36.10	2.78	3.02	.003	86

Table 2 shows a mean score of 39.19 (experimental group) and a mean score of 36.10 (control group). This shows that there is a statistically significant mean differences in the post test scores of the two groups, with the experimental group performing better than the control group. Thus, the null hypothesis was rejected. This remarked that the treatment (personalised approach) applied to the experimental group was effective.

H_O3: There is no significant mean difference in the pre and post-test scores of the control group.

Table 3: Mean differences in the in the pre and post-test scores of the control group

Variables	N	Mean	Std.dev	t-cal	p-value	df
Control group (pretest)		36.50	2.78			
Control group (posttest)	35	36.10	3.79	-1.81	0.09	34

Table 3 shows that there is no significant mean difference in the pretest scores (36.50) and the post test (36.10) scores of the control group. Consequently, the hypothesis was not rejected. This shows that the conventional method applied on the group wasn't enough to improve their achievement in Basic Science.

H_O4: There is no significant mean difference in the pre and post-test scores of the experimental group.

Table 4: Mean differences in the pre and post test scores of the experimental group

Variables	N	Mean	Std.dev	't'	p-value	df
Experimental group (pretest)		37.19	3.21			
Experimental group (posttest)	52	39.19	3.33	-3.19	0.00	51

Table 4 shows a mean score of 37.19 (experimental group) at pretest level and a mean of 39.19 at the post test level. This shows that the performance of the experimental group was statistically and significantly increased after the treatment was applied. This signifies that the personalised learning approach was better than the conventional method of teaching Basic Science.

The study investigated the effect of personalised learning on achievement in Basic Science. The results showed a significant difference between the achievements of the experimental and the control groups, implying that the experimental cohorts performed better than control group. This result shows that the use of personalized learning methods is effective for the teaching and learning of Basic Science in junior secondary schools. Several reports abound on the gains of personalizing learning for students. Personalized learning has the capacity of revolutionizing education [22, 21]. According to [23] who reported that for meaningful learning to take place, there is the need for a suitable channel of content presentation to students. Therefore, a sound knowledge of the principles of pedagogical effectiveness in science teaching and learning, which include knowledge of students' psychology, science contents mastery, knowledge of instructional methods, conducive environment for learning, among others are needed. The finding also aligns with the report of [26] who reported that using ICT tools in instruction is an important consideration and inclusion in instructions. This also corroborates [25] that reported that the utilization of ICT in instructions cannot be overemphasized just as [26] reported that using ICT tools in instruction is an

important consideration and inclusion in instructions. Personalized learning for students improves flexibility which supports mastery, thereby enabling students to influence how, what, when, and where they learn [15, 21]. [18] have reported that students of this Century (the digital natives or millennials) grow up using technology at an early age which was not the norm many years back. Therefore, they learn differently from those before them because technology and modern strategies have become a way of life for them. They have information at their fingertips due to the Internet and other ICT gadgets readily available to them [14].

Within this context, personalised learning as a concept increasingly advocates that learning should not be time, barrier and place restricted, and must be continuously tailored and modified to individual student's needs; their abilities, knowledge status, and interests among others. This method therefore implies a radical departure from traditional method of instruction to a personalised learning situation. The finding implies that students' learning need to be supported with relevant ICT-based personalised learning tools in order to improve their performance and mastery of the contents of science. It is of note that there cannot be sustainable development in any nation that ditches science learning. This is because for such nations to develop and join the leagues of nations using scientific and technological knowledge to advance, they must, without delay improve how their citizens approach and learn science. In doing this, they can leverage on the advantages which the inclusion of ICT in education has brought to fore.

CONCLUSION

The finding of the study has shown that there is no statistically significant mean differences in the pre-test scores of the experimental and control groups examined in the study. However, there is statistically significant mean differences in the post-test scores of the experimental and control groups. Also, the study revealed that there is no statistically significant mean differences in the pre and post-test scores of the control group, whereas there is a statically significant mean differences in the pre and post-test scores of the experimental group. With specific reference to the performance of the experimental group, the statistical improvement in their performance over the control group was facilitated by the use of ICT-based personalised learning which has proven to be an effective means of teaching not just Basic science, but science in general. Given this, the use of personalized learning strategy is effective for the learning of Basic Science. Therefore, the use of computer-assisted learning packages in teaching and learning is an effective mode of instruction for students in this Century. In view of this, the study recommended that educators design and make use of personalized instructional packages in supporting their teaching and learning processes in order to make learning more personalised for students. Also, educators should be trained and retrained as the case may be on effective handling of personalized instructional models in and outside the classrooms. Finally, the Government should invest in modern Computer-Assisted Learning Packages and distribute such to teachers and students for use in teaching and learning.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest in this work.

REFERENCES

[1] Urevbu, A. O (2001). Methodology of Science Teaching, Juland Education Publishers. Lagos. p47

[2] Odili, G. O. (2012). Towards a New Paradigm of Teaching Mathematics in Nigerian Universities: The Role of Mathematics Educators. *Online Journal of Science Teachers Association of Nigerian (STAN),* 47(1).

[3] Alamu, S. A. (2011). The State of Science and Technology Infrastructure in Secondary Schools in Nigeria. *Journal of Educational and Social Research.*

[4] Omoifo, C. N. (2012). Dance of the Limits, Reversing the Trends in Science Education in Nigeria. Inaugural Lecture University of Benin, Benin City. Dubem Publishers: Benin. p56
[5] Olasehinde, K. J. & Olatoye, R. A. (2014). A Comparative Study of Public and Private Senior Secondary School Students' Science Achievement in Katsina State, Nigeria. *Journal of Educational and Social Research, MCSER Publishing, Rome-Italy*, 4 (3), 20.
[6] Federal Republic of Nigeria (FRN) (2014). National policy on education. Lagos: Federal Government press. p34
[7] National Policy on Education (2014). Abuja: NERDC. p34
[8] Ajayi, O. A. & Adelana, O. P. (2020). Effectiveness of multimedia self-learning package in teaching and learning of genetics in secondary schools. *Journal of Psychometry and Assessment Techniques*, 1 (1), 201
[9] Olutola, O. A., Daramola, E. S. & Bamidele, E. O. (2016). Assessing Students' Performance in Senior School Certificate Multiple Choice Test in Biology. Issues and Ideasin Education, 4 (1), 11–20.
[10] Suman, B. (2011). Influence of parental education and parental occupation on academic achievement of students. *International Referred Research Journal*, 3(30), 32-33
[11] Ogunshola, F. & Adewale, A. M. (2012). The effects of parental socio-economic status on academic performance of students in selected schools in Edu LGA of Kwara state Nigeria' *International Journal of Academic Research in Business and Social Sciences,* 2(7), 230-239.
[12] Dinah, C. S. (2013). Factors which influence academic performance in biology in Kenya: a perspective for global competitiveness. *International Journal of Current Research,* 5(12), 4296-4300.
[13] Akinsanyo O., Ajayi, K. O. & Salomi, M. O. (2014). Relative effects of parents' occupation, qualification and academic motivation of wards on students' achievement in senior secondary school mathematics in Ogun state. *Journal of Education and practice,* 5(22),99-105.
[14] Abolarinwa, l. F., Gambari, A. I., Falode, O. C.1, & Uno, U. (2020). Development and validation of flipped classroom instructional model for Senior Secondary II (SSII) Physics students in Minna, Nigeria. Journal of Science, Technology, Mathematics and Education (JOSTMED), 16(4), 3
[15] Patrick, S., Kennedy, K., & Powell, A. (2013). Mean what you say: defining and integrating personalized, blended and competency education. Vienna, VA: International Association for K-12 Online Learning.
[16] Demetrios, S. & Charalampos, K. (2002). Personalised learning: educational, technological and standardization perspective. *Interactive Educational Multimedia*, 4, 24-39 http://www.ub.es/multimedia/iem
[17] Keamy, R., Nicholas, H., & Mahar, S., & Herrick, C. (2007). Personalising Education: from research to policy and practice. Published by Education Policy and Research Division Office for Education Policy and Innovation Department of Education and Early Childhood Development Melbourne. © Copyright State of Victoria 2007. ISBN 978-0-7594-0473-1
[18] Roehl, A., Reddy, S. L., & Shannon, G. J. (2013). The Flipped Classroom: An opportunity to engage millennial students through active learning strategies. *Journal of Family and Consumer Sciences,* 105(2), 44-49. https://www.learntechlib.org/p/154467/.
[19] Pennington, R. C., Ault, M. J., Schuster, J. W., & Sanders, A. (2011). Using simultaneous prompting and computer-assisted instruction to teach story writing to students with autism. *Assistive Technology Outcomes and Benefits*, 7, 24–38.
[20] Coleman-Martin, M. B., Heller, K. W., Cihak, D. F., & Irvine, K. L. (2005). Using computer-assisted instruction and the nonverbal reading approach to teach word identification. *Focus on Autism and Other Developmental Disabilities,* 20, 80–90.
[21] Basham, J. D., Hall, T. E., Carter, R. A., & Stahl, W. M. (2016). An operationalized understanding of personalized learning. *Journal of Special Education Technology*, 31(3), 126-136
[22] Duncan, A. (2013). How technology will revolutionize testing and learning: Greater broadband access will bring the latest digital tools to more teachers and students. *Scientific American,* 309, 69–71.
[23] Danjuma, B. (2015). Effects of Computer-Assisted Instruction on academic achievement among NCE Physics students of different abilities in Niger State, Nigeria. A thesis submitted to School of Postgraduate Studies, Ahmadu Bello University, Zaria, in partial fulfillment of the requirements for the award of Master Degree in Science Education, Department of Science Education, Faculty of Education, ABU, Zaria, pp45-47.
[24] Chifwa, J. (2015). The teaching of genetics in selected secondary schools in Kitwe District, Zambia. A dissertation submitted to the University of Zambia in fulfilment for the Requirements of the Degree of Master of Education in Science Education. p17
[25] Abubakar, A. M. (2016). An Assessment of the Use of ICT in Teaching and Learning in Public Secondary schools in Northeastern Nigeria. Submitted to the Institute of Graduate Studies and Research in partial fulfillments of the requirements for the degree of Master of Science in Information and Communication Technologies in Education. 45-47
[26] Williams, K. (2010). Using information technology: A practical introduction to computer and communication. *J. Science Teach. Nig., 4*(1), 174-180.

[27] Bonwell, C. C., & Eison, J.A. (1991). *Active learning: creating excitement in the classroom*. ASH#-ERIC Higher Education Report No. 1, Washington, D.C.: The George Washington University, School of Education and Human Development.

[28] Brame, C. (2016). Active learning. Vanderbilt University Center for Teaching. Retrieved on 5 September, 2021 from https://cft.vanderbilt.edu/active-learning/.

[29] Hake, R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics 66*, 64-74.

[30] Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education 93*, 223-231.

[31] Springer, L., Stanne, M.E., & Donovan, S.S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology. *Rev. Educ. Res. 69*, 21–51.

[32] Ruiz-Primo, M.A., Briggs, D., Iverson, H., Talbot, R., & Shepard, L.A. (2011). Impact of undergraduate science course innovations on learning. *Science 331*, 1269–1270.

[33] Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences USA 111*, 8410-8415.

[34] Department for Education and Skills (2006b). *Personalised learning: adding value to the learning journey*, DfES, UK. Retrieved from http://www.standards.dfes.gov.uk/ personalisedlearning/about/ on 05 September 2021,