

Comparative Effect of Guided Discovery and Self-Learning Teaching Strategies on Senior Secondary Student's Achievement in Physics in Makurdi Local Government Area of Benue State Nigeria

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Abstract: *The study investigated the comparative effect of guided discovery and self-learning teaching strategies on senior secondary student's achievement in physics in makurdi local government area of Benue state, Nigeria. Four objectives were set for the study which are to determine the difference in mean achievement scores of students taught physics using guided discovery approach and those taught using self-learning method, determine the relationship between the mean achievement scores of students taught physics using guided discovery and those taught using self learning method, determine the effect of the mean achievement scores of student taught physics using guided discovery and those taught using self learning method and determine the difference in mean achievement scores of male and female student taught physics using guided discovery and those taught using self learning method. A total of 340 students were used for experimentation Physics Achievement Test (PAT)). The purposive sampling techniques was used with the sample size of 340. Data was analyze using descriptive statistics of means and standard deviation. The results showed that that there is a significant main effect of treatment on students' achievement in Physics in guided discovery strategy experimental group and self learning strategy but no significant effect in conventional strategy which serves as control group in Makurdi LGA and there is a significant main effect of cognitive style on students' achievement in Physics in guided discovery, self learning and conventional strategies respectively in Makurdi LGA. Based on the finding of the study, the study concluded that; there is a significant difference in students' achievement in Physics between students taught using the guided discovery teaching method and those taught using the self learning method, those taught with guided discovery teaching method performed better than those taught with self learning method, there is no difference in students' achievement in Physics between male and female students taught with the guided discovery teaching method, there is a difference in students' achievement in Physics between students in Female schools and students in Male schools taught with guided discovery teaching method and Students in the Male areas performed better than students in Female areas in terms of students' achievement in Physics in self learning method.*

Keywords: *effect, comparative, guided discovery, self-learning, strategies, secondary, school.*

1. INTRODUCTION

Physics is the branch of science concerned with the nature and properties of matter and energies. (H.C. Verma) The subject matter of physics includes mechanics, heat, light and other radiation, sound, electricity, magnetism, and the structure of atoms. Despite the importance placed on physics, students' achievements in the subject at both terminal school examination and external (WASSCE and NECO) examinations have been repeatedly inconsistent NECO 2014. The inconsistent achievements of students in physics becomes more evident, looking at the records of the West African Examination Council (WAEC) results over the years which m h reveals that physics has a high number of students' enrolment yearly in the Senior School Certificate Examination but records inconsistent achievements over the years.. The inconsistent achievements of students in Physics may likely be associated with the use of ineffective methods of teaching. Despite the recommendations for use of innovative methods for teaching and learning science by the Federal Ministry of Education and suggestions by many Science Educators, reports from educators and researchers indicated that students' achievements in Physics is still not encouraging. With Stanford's Centre for Teaching and Learning (CTL) (2013) That, guided-discovery encourages students' natural curiosity. Carefully constructed puzzles, problems, and questions push students to go beyond facts to discovery of principles in solving problems.

Guided discovery is one of those teaching methods that employ exploration, manipulation and experimentation to find out new ideas; it is a problem solving oriented method Akuma, (2008). Guided discovery instructional strategy, is characterized by convergent thinking. The instructor devises a series of statements or questions that guide the learner, step by logical step, making a series of discoveries that leads to a single predetermined goal. In other words, the teacher initiates a stimulus and the learner reacts by engaging inactive inquiry thereby discovering the appropriate response. Extensive review of the literature by DeJong and Jooling showed that generally speaking guided simulation discovery leads to better results than non-guided ones. It aided better understand of concepts and of course better train for the discovery process itself. (DeJong & Joolingen, (2003). According to Okoye, (2004) and Nwagbo (2004), during the early 70's the rational for science teaching shifted as discovery strategy was adopted worldwide. This was because

students tended to memorize facts and concepts, most of which they did not understand. This resulted in a lack of retention and application of concepts. They maintained that there was a great burst of interest as the guided discovery strategy was adopted in the Nigeria curriculum. The guided discovery strategy is activity oriented and involves practical demonstration, discussion and experimentation. During such instruction the students employ the processes of science like observation, classification, investigation and critical interpretation of findings. In Physics, it is possible for guided discovery strategy of teaching to be enhancing students' performance. This is because of the activity oriented nature of the guided discovery strategy (Okoye, Momoh, Aigbomain, and Okecha, 2008)..

The classroom teachers conduct formative and summative tests to evaluate students' mastery of course content and provide grades for students. This relative achievement of students is an example that has internal and external impact depending on the method adopted by the teacher. It is in the light of the above discussed, variables that form the background of the study was set on effect of Guided Discovery and tutorial teaching methods on Achievement of physics Students in Makurdi Local Government. Gender is a construct that is used to differentiate male from female (boys from girls). It is defined as a cultural difference between male and female base on the biological division (Mberekpe, 2013). Gender issue is a contemporary one that attracts attention of psychologists, sociologist, educationist, scientists and biologists and even the home and parents. The concept "gender" could be discussed in term of masculinity and femininity observed in an individual. The physical character of an individual may not be expressed psychologically or emotionally. For instance, careers or subject that are feminine in nature such as catering, is practiced by boys while girls are studying engineering and carpentry meant for boys previously. A lot of researches have been carried out on gender and paper presentations to create awareness on gender equality and disparity. Ifumuyiwa (2003) reported that 215 candidates sat for further Physics in school certificate Examination, 181 males and 34 females. The analysis indicates low participation of females 16% to 84% male but yet the females performed better than their male counterparts at credit levels in the subjects. This low participation of female students in science related subjects were attribute factors such as: - attitude of teachers, students and parents to the idea of women engaging in male career such as Engineering, Technology, Architecture and others.

Research Questions

The following questions were set for answering:

1. What is the difference in mean achievement scores of students taught physics using guided discovery strategy and those taught using self-learning method?
2. What is the relationship between the mean achievement scores of students taught physics using guided discovery and those taught using self-learning method?
3. What is the effect of the mean achievement scores of students taught physics using guided discovery and those taught using self learning method?
4. What is the difference in mean achievement scores of male and female students taught physics using guided discovery and those taught using self learning method?

Statement Hypotheses

The following statements of hypotheses were formulated to guide the study and will be tested at 0.05 level of significance.

HO₁: There is no significant difference in the mean achievement scores of students taught physics using guided discovery approach and those taught using self learning method

HO₂: There is no significant difference in the relationship between the mean achievement scores of students taught physics using guided discovery and those taught using self learning method.

HO₃: There is no significant difference in the effect of the mean achievement scores of student taught physics using guided discovery and those taught using self learning method.

HO₄: There is no significant difference in the mean achievement scores of male and female students taught physics using guided discovery and those taught using self learning method.

2. METHODOLOGY

Design

The research design that will be employed is quasi experimental design of pretest-posttest group. The justification for employing quasi experimental design is because; it is not possible for the researcher to meet all the conditions of a true experiment design. Hence, intact classes will be randomly assigned to experimental and control groups. Intact classes are randomly assigned to avoid disrupting the school activities. Both the experimental and control groups is given the same pretest before treatment and posttest after the treatment as well as the retention test after two weeks of treatment

The Study Area

Makurdi Local Government Area of Benue State is the study area. The local government was established in 1927. It became headquarter of Benue State province in 1976. It is located at the latitude of 7.73° North and longitude of 8.54°. Makurdi local government area is bounded by Guma local government in the North, south by Gwer-East local Government area, in the east by Tarkaa local Government area and in the West by Gwer-West local government area. It has eleven council wards which include;

Agan, Ankpa/wadata, bar, central/south mission, clerk/market, Fildi, Mbalagh, Morden market, North bank I, North bank II and Wailomayo council wards. The area is predominantly an agricultural catchment area specializing in cash crops, subsistence crops and variety of potentials.

The major ethnic groups in makurdi are the Tiv, Idoma and Igede. Other minor ones are Jukun and Hausa. There are also economically significant numbers of non-indigenous ethnic groups in the state such as Igbo, Yoruba and Igala who are mostly traders. The indigenes are mostly farmers and civil servants.

The Tertiary Institutions in Makurdi include a Joseph SarwuanTarkaa University Makurdi, Benue State University Makurd (State University), National Open University of Nigeria Makurdi Study Centre, Akawe Torkula Polytechnic Makurdi, the Schools of Nursing and Midwifery in Makurdi.

Makurdi also has many secondary and primary schools including government, private and missionary schools. The justification for the choice of the makurdi local government area is because of the poor achievement and retention of Physics students in WEAC examination over the years. This study may provide a dependable strategy that will improve students' achievement and retention in Physics.

Population of the Study

The population of a study will consist of 2300 Senior Secondary School SS II Physics students in 20 government grant aided schools in Makurdi Local Government Area of Benue State (Benue State Ministry of Education, 2018). The government grant aided schools are preferred because their establishment and operation is based on the state Ministry of Education operational mandate and guidelines.

Sample and Sampling Techniques

The study used a sample size of 340 Senior Secondary SSS II Physics students drawn from six Schools in Makurdi Local Government Area. Purposive sampling techniques and Simple random sampling techniques were used at different stages. Sampling techniques was adopted to select six (6) schools from government grant aided schools in Benue State. The sample size of the population is taken using Taro Yamane's formula for accuracy and the selection of the school is based on the government grant aided schools with qualified Physics teachers who study Physics education at first degree level and above, the Physics teachers must possess five years of teaching experience from co-education schools, since gender is moderator variable. Simple random sampling techniques (balloting without replacement) will be used in assigning intact lasses from the selected schools to experimental and control groups respectively.

Instrument for Data Collection

The instrument to be used for the study will be Physics Achievement Test (PAT) to establish the group 1. Guided Discovery, 2. Self-learning, 3. Control group of the experimental and control groups. This enables the researcher to ascertain the comparative effect on achievement using Physics when teaching SSII students magnetism and wave.

Physics Achievement Test (PAT)

The Physics Achievement Test (PAT) is made up of 40 items multiple choice objective test questions with four options per question. These are based on secondary school new curriculum developed by Nigeria Educational Research and Development Centre (NERDC) for senior secondary schools. The test items developed is based on the following topics; student's magnetism and wave. The topics are taken from essential Physics text book and Physics passed questions for secondary schools. The PAT contains two sections namely: section A and B. section "A" contains the demographic information of respondents while section "B" contains 40 multiple choice items. Each of the items has options A-D from which respondents is expected to choose the correct option. The correct answer will be giving by ticking the letter bearing the correct answer to the question. Each question carries two marks.

Validity of Instrument

The Physics Achievement Test was validated by three experts, one in Measurement and Evaluation Joseph Sarwuan Tarka University Makurdi, one in the Department of Science Education Joseph Sarwuan Tarka University Makurdi and another one from public School. The experts are requested to critically examine the PAT and BRT and advised the researcher on the scope, content, relevance suitability and appropriateness of the instrument in accomplishing the objective of the study. The experts assess the language of the instrument. The experts also checked the lesson plans and the marking schemes whether the answers to PAT are correct or not. The experts made corrections and suggestions.

Reliability of Instruments

A trial-testing of PAT was conducted using Physics student's of Golden College North Bank Makurdi, Benue State. Forty copies of the instruments were distributed to thirty students (Appendix K. pg. 88). The reliability coefficient of the instrument (PAT) was found to be 0.909 using Kuder-Richardson formula ($K-R_{20}$) (Appendix k. pg. 90). The justification for using Kuder-Richardson formula ($K-R_{20}$) is because the items are scored dichotomous. That is, two points for each correct answer and zero for incorrect answer Emaikwu (2011).

Method of Data Collection

The method of data collection was face to face administration of PAT by the research assistants. The researcher develop a training Manual that was used to train the SSII Physics teachers from each of the schools that will be selected which will served as research assistants. The research assistants will administer the Physics Achievement Test (PAT) before treatment (pre-test), give the treatment and administer the Physics Achievement Test (PAT).

Experimental Procedure

The treatment commence with administering pre-test (PAT) follow by lessons on waves and magnetism. Each lesson will last for 40minutes with three periods per week both on experimental and control group. Two lessons notes, one for experimental group and another one for control group. The treatment will last for six (6) weeks, week1 for familiarization and administration of pre-test, week 2-4 treatments, week5 administration of post-test, week 6 making and coding of post-test scores. After two weeks of treatment and post-test Physics was administered making six weeks in all.

Control of Extraneous Variables.

The following extraneous variables that will result to research subjectivity was taken care of thus:

Hawthorne effect: This occurs when the subjects for the experiment are aware that they are being used for an experiment. In order to eliminate this effect, the students regular Physics teachers of the schools was train and used for both the experimental and control groups. This will help to reduce students' suspicion that would have been arising if the researcher was involved in the treatment (teaching).

Teacher qualification variables: variability that might arise due to teacher qualification will be eliminated by research assistants who will be trained before the commencement of the study.

3.9 Method of Data Analysis

Descriptive statistics of Means of Standard Deviation was used for answering all the research questions while inferential statistics of Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The decision rules any value less than 0.05 is accepted otherwise reject. ANCOVA is use when there is need to control for an additional variable which may be influencing the relationship between the independent and dependent variables and by doing this, the researcher removes the bias or likelihood that the intact groups not homogenous or equivalent Emaikwu (2019).

3. RESULTS

The results of the analysed data were presented, and the research questions raised were answered using mean and standard deviation. The t-test statistics were used to test the hypotheses formulated for the study at 0.05 level of significance.

Research question 1: What is the difference in mean achievement scores of students taught physics using guided discovery approach and those taught using self learning method?

Table 1: Comparison of Pre-test Scores of Students taught with Guided Discovery and self learning Methods.

Teaching Method	N	Score	SD	Std Error
Guided Discovery	170	25.1	10.12	.69
Self learning	170	24.8	11.15	.63

Table 1 showed the mean and standard deviation of students under guided discovery and self-learning methods. The guided discovery method has a mean of 25.1 and standard deviation of 10.12 while self-learning method has a mean of 24.8 and standard deviation of 11.15. Both groups had low mean and high standard deviation. This implies that before the treatment, there was low achievement by the students. The standard deviations showed a heterogeneous achievement by the students.

Research question 2: What is the relationship between the mean achievement scores of students taught physics using guided discovery and those taught using self learning method?

Table2: Comparison of Mean Achievement Scores of Students taught with Guide Discovery and those taught with self-learning Methods.

Teaching Method	N	Mean	Std. Deviation	Std. Error Mean
Guided Discovery	170	73.46	11.13	.88
Self-learning	170	46.08	6.48	.51

Table 2 above showed that the mean and standard deviation of those taught with guided discovery method are 73.46 and 11.13 while those taught with self-learning method are 46.08 and 6.48 respectively indicated that there is a difference in students' achievement in Physics between students taught using guided discovery method and those thought using self-learning method.

Research Question3 What is the effect of the mean achievement scores of student taught physics using guided discovery and those taught using self learning method?

Table 3: Comparison of Mean Achievement Scores of student taught physics using guided discovery and those taught using self learning method.

Teaching Method	N	Mean	Std. Deviation	Std. Error Mean
Guided Discovery	370	68.65	15.74	1.63
Self learning	370	49.00	7.27	.89

Table 3 above showed that the mean and standard deviation of students in Guided Discovery taught with self method of teaching are 68.65 and 15.75 while students in Self learning schools taught with self method of teaching are 49.00 and 7.27 respectively there is a difference between students in Self learning schools and students in Guided Discovery, when taught with Self learning method of teaching.

Research question4:

What is the difference in mean achievement scores of male and female student taught physics using guided discovery and those taught using self-learning method?

Table 4: Comparison of Mean Achievement Scores of student taught physics using guided discovery and those taught using self-learning method.

Teaching Method	N	Mean	Std. Deviation	Std. Error Mean
Male	170	73.33	12.85	1.41
Female	170	72.8	29.27	1.06

Table 4 above showed that the mean and standard deviation of male taught with guided discovery method are 73.33 and 12.85 while female taught with guided discovery method are 72.82 and 9.27 respectively. There is no difference in students' achievement in Physics between male and female students taught with the guided discovery teaching method.

H_{01} : There is no significant difference in the difference in mean achievement scores of students taught physics using guided discovery approach and those taught using self learning method

Table 5: ANCOVA Comparison of Achievement Scores of Students taught with Guided Discovery and those taught with self learning Methods.

Groups	N	Mean	SD	Df	t-cal.	t-crit.	Decision
Experimental Group (Guided Discovery Method)	340	73.46	11.13	318	26.90	1.96	H_{01} Rejected
Control Group (Self learning Method)	160	46.08	6.48				

Table 5 showed the t-test analysis of students' mean achievement test score in Physics between students taught using the guided discovery teaching method and those taught using the self learning method. Result showed that the t-calculated value of 26.90 was greater than the t-critical value of 1.96 at a degree of freedom of 318. Since the t-calculated value is greater than t-critical value at 0.05 level of significance, the null hypothesis therefore was rejected. Hence, there is a significant difference in students' mean achievement test score in Physics between students taught using the guided discovery teaching method and those taught using the self learning method.

Hypothesis 2 There is no significant difference in the relationship between the mean achievement scores of students taught physics using guided discovery and those taught using self learning method.

Table 6: ANCOVA Comparison of Achievement Scores of students taught physics using guided discovery and those taught using self learning method.

Group	N	Mean	SD	Df	t-cal.	t-crit.	Decision
Experimental Group							

(Guided Discovery Method)	340	47.57	7.04	158	2.87	1.96	HO3	Accepted
Control Group								
(Self learning Method)	83	44.69	5.60					

Table 6 showed the t-test analysis male and female students' mean achievement test score in Physics taught with self method of teaching. Result showed that the t-calculated value of 2.87 was less than the t-critical value of 1.96 with a degree of freedom of 158. Since the t-calculated value is less than t-critical value at 0.05 level of significance, the null hypothesis therefore was accepted. Hence, there is no significant difference in mean achievement test score in Physics taught with self method of teaching.

Hypothesis 3 There is no significant difference in the effect of the mean achievement scores of student taught physics using guided discovery and those taught using self learning method.

Table 6: ANCOVA Comparison of Achievement Scores of student taught physics using guided discovery and those taught using self learning.

Group	N	Mean	SD	Df	t-cal.	t-crit.	Decision
Experimental Group							
(Guided Discovery Method)	170	73.33	12.85	158	0.28	1.96	HO2 Accepted
Control Group							
(Self learning Method)	170	72.82	9.27				

Table 6 showed the t-test analysis students' mean achievement test score in Physics between male and female students taught with the guided discovery teaching method. Result showed that the t-calculated value of 0.28 was less than the t-critical value of 1.96 with a degree of freedom of 158. Since the t-calculated value is less than t-critical value at 0.05 level of significance, the null hypothesis therefore was accepted. Hence, there is no significant difference in students' mean achievement test score for those taught with the guided discovery teaching method.

Hypothesis 4: There is no significant difference in the difference in mean achievement scores of male and female student taught physics using guided discovery and those taught using self learning method.

Table 7: ANCOVA Comparison of Achievement Scores of male and female student taught physics using guided discovery and those taught using self learning method.

Gender	N	Mean	SD	Df	t-cal.	t-crit.	Decision
Male	170	74.17	12.46	158	10.25	1.96	HO4 Rejected
Female	170	53.34	12.99				

Table 7 showed the t-test analysis students' mean achievement test score in Physics between students in Female schools and those in Male schools taught with guided discovery teaching method. Result showed that the t-calculated value of 10.25 was greater than 54 the t-critical value of 1.96 with a degree of freedom of 158. Since the exact probability value is greater than the significant level of 0.05, the null hypothesis therefore was rejected. Hence, there is a significant difference in students' mean achievement test score in Physics between students in Female schools and those in Male schools taught with guided discovery teaching method. Hypothesis 5 (HO5) There is no significant difference between Male and Female students' mean achievement test score in Physics taught with self method of teaching. Table 16: t-test Comparison of Achievement Scores of Students in Male and Female Schools taught with self learning Method.

5. DISCUSSION OF RESULTS

The results indicated that there is a significant main effect of treatment on students' achievement in Physics in guided discovery strategy experimental group and self learning strategy but no significant effect in conventional strategy which serves as control group. These indicate that guided discovery strategy and self learning strategies is capable of improving students' achievement in Physics. The finding is in consonance with the results of researchers in guided discovery strategy: Onanuga (2004) concluded that the use of discovery method caused the students who are exposed to it to perform better than students exposed to conventional method of teaching. His finding was also in agreement with Ugwanyi (2008), who noted that the guided discovery method of instruction is more effective than the commonly used expository methods in Physics. The students are more likely to remember concepts they discover on their own. Mayer, (2004) asserted that teachers have found that discovery learning is most successful when students have prerequisites knowledge and undergo some structured experiences.

The result of this study showed that there was a significant main effect of cognitive style on students' achievement in Physics in guided discovery, self learning and conventional strategies respectively. The indication of this result is that students' cognitive style influence students' achievement in Physics. The result negate the finding of Carolina et al. (2012) in their study of influence of the cognitive style called Field dependence and field independence on academic achievement of Brazilian university student; they found that cognitive style and learning strategy significantly contributed to academic achievement. It supports the findings of Olagunju & Ogundiwin, 2008.

The findings from this study have tremendous and meaningful implication for teachers of Physics, school administrators, counsellors and education policy makers. Guided discovery and self-learning strategies have statistically significant main effect on students' academic achievement in Physics. These findings have created an opportunity for improving the teaching and learning of Physics through the use of guided discovery and self-learning strategies to impart knowledge to the learners'. Teachers of Physics should come to terms with introducing studentcentre learning rather than teacher- centre learning in the learning of Physics concepts. From this research study, it can be inferred that guided discovery and self-learning strategies fosters the development of practical skills which is intended to stimulate healthy intellectual climate for people to interact effectively among themselves with minimal friction. The teachers' role in both strategies is not to transmit information but to serve as facilitators for learning which includes creation and managing meaningful and impactful learning experiences, thereby, stimulating students' thinking through and appreciating a better way of solving real world challenges. The teaching of Physics is far becoming more of a theoretically oriented learning rather than allowing students to learn effectively through acquiring necessary skills from guided discovery and self-learning strategies as these equip them to have a balance between structure and flexibility, learner autonomy and tutor control in a learner support strategies that is based on individual learning capabilities which will in effect facilitate self discovery. It is, therefore, imperative for teachers of Physics to assume the stage of using teaching and learning strategies that will facilitate effective and stimulating teaching-learning environment.

On the basis of the findings of this study, the following recommendations are made:

1. The use of guided discovery and self-learning should be encouraged in schools for effective teaching and learning of Physics. Teachers of Physics should be ready to incorporate these teaching strategies.
2. Facilities and suitable learning environment should be provided, to allow effective teaching and learning in a learner-centred situations.
3. Teachers should provide the structure and opportunities for learners to do guided discovery and self-learning so as to improve leaning achievement. This research has the potential of increasing the understanding of the way Nigerian schools can move towards improving learning capabilities and effectiveness by providing quality learning environment and opportunities to learners at all levels.

6. Conclusion

The major conclusions reached from the findings of the results were that:

1. There is a significant difference in students' achievement in Physics between students taught using the guided discovery teaching method and those taught using the self learning method.
2. Those taught with guided discovery teaching method performed better than those taught with self learning method.
3. There is no difference in students' achievement in Physics between male and female students taught with the guided discovery teaching method.
4. There is a difference in students' achievement in Physics between students in Female schools and students in Male schools taught with guided discovery teaching method.
5. Students in the Male areas performed better than students in Female areas in terms of students' achievement in Physics in self learning method.

7. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made.

1. Guided discovery teaching method should be practiced intensively by Physics teachers since the method has been proved effective in enhancing students' academic achievement.
2. Physics teachers should reduce the use of self method in teaching Physics to enhance students' academic achievement.
3. Physics teachers should make the teaching-learning of Physics an interactive and activity-based for the students using guided discovery method.
4. Government at all levels should periodically conduct regular workshops for teachers on the effective use of guided discovery teaching method.
5. Government should also encourage Physics teachers to use guided discovery method by providing the needed conducive environment for teaching and learning with adequate instructional materials.

REFERENCES

- Abimbola, I.O. (2013). The Misunderstood Word in Science towards a Technology of Perfect Understanding of All. In 123rd Inaugural Lecture of University of Ilorin (p.22-31) Unilorin Press.

- Adegboye, A.O. & Adegboe, O.A. (2003). An Investigation into Secondary School Students Performance in SSCE Mathematics Lafiagi. *Journal of Science Education* 5, 192:25-31.
- Adeniyi, A.G. (2005). Science and Technology Education in Secondary Schools: Need for Manpower Development. *Journal of the Science Teachers Association of Nigeria*, Vol. 40, No. 1 & 2: 63-67.
- Adepitan, J.O. (2003). Pattern of Enrolment on Physics and Students Evaluation of the Contributory Factors on Nigeria Colleges of Education; *African Journal of Education Research* (2) pp. 136-146.
- Adesoji, F.A. (1986). The Uses of Self-Learning Device in Improving Chemistry Teaching. 27th Annual Conference Proceedings.
- Adesoji, F.A. (2004). Science and Curriculum Development: An Unpublished M.Ed. Lecture.
- Adeyegbe, S.O. (2000), Packaging Science, Technology and Mathematics Education to Maximize Standard, Progression and Continuity: Challenging of the Twenty-First Century. Keynote Address at 4th Annual Conference of Science Teachers Association of Nigeria (STAN), Lagos State Branches.
- Afuwape, M.O. (2004). The Effect of Computer-Assisted Instruction on Students' Attitude Towards Integrated Science. *Nigeria Journal of Computer Literacy (NJCL)* 5.
- Aiyelagbe, G.O (2003). The Effectiveness of Audio, Visual and Audio - Visual Self Learning Packages in Adult Learning Outcomes in Basic Literacy Skills in Ibadan. Unpublished Ph.D Thesis, University of Ibadan.
- Ajewole, G.A. (2007). Effects of Discovery and Expository Instructional Methods on the Achievement of Students in O Level Biology. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.
- Ajewole, G.A. (2007). Teaching Terrestrial Habitat in Biology to students in African Secondary Schools for Sustainable Development. *Proceedings of 43rd Annual Conference of Science Teachers Association Nigeria*, Nzewi, Uchenna Ed. Ibadan, HEBN 287-290.
- Ajiboye, J.O. (1997). A Self-Learning Programme, The Modified Lecture Method and Students Cognitive and Effective Outcomes in Some Population Education Concepts. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.
- Ajileye, O.O. (2006). Towards Effective Science Education: Issues in Universal Basic Education Programme. *Journal of Sports Management and Educational Research*. 1, 2: 337.
- Akanbi, A.O. (2003). Trend in Physics Educational in Secondary School in Kwara State. Lafiagi. *Journal of Science Education*, 5, 1&2: 69-75.
- Akinmoyewa, J.O. (2003). Effects of Co-operative, Competitive and Individualistic Use of Self-Instructional Package Learning Achievement in Biology. *Journal of Education and Society*.
- Akinolu, B.M.A. (2006). Causes of Mass Failure in Senior Secondary School Chemistry in Ijebu East Local Government Area of Ogun State. *Oro Science Educational Journal*. 4, 5 & 6:19.
- Akuma, N. (2008). Effects of Guided Discovery Method on Senior Secondary Students, Interest in Map Work. *African Journal of Educational Research*. 12, 2: 111-116.
- Alebiosu, K.A. (2003). Effects of Co-operative Learning Models on Senior Secondary Students Learning Outcomes in Chemistry. Unpublished Ph.D Thesis, University of Ibadan.
- American Association for the Advancement of Science (1989). Science for All Americans. A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology, Washington, DC.
- Apata, S.F. (2007). Influence of Teachers Academic Qualification and Experience on Students Performance in Senior Secondary School Physics in Kwara State (Unpublished Master Thesis). University of Ilorin, Ilorin.
- Asim, A.E. (2003). An Evaluation of the Effectiveness of Two Interactive Approaches Based on the Constructivists Perspective for Teaching Primary School Science, Unpublished Ph.D Thesis, University of Ibadan, Ibadan.
- Augustine, N.R. (2005). Rising Where the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. Washington D.C.: National Academy of Science, National Academy of Engineering, Institute of Medicine, National Academy Press.
- Awolola, S.A. (2009). Impact of Brain- Based Instructional Strategy on Students Learning Outcome in Senior Secondary School Mathematics in Selected Local Government Areas in Oyo State, Nigeria. Unpublished Ph.D Thesis, University of Ibadan.
- Biswas, G. and Leelawong K. (2007). Pedagogical Agent for Learning and Teaching: Teachable Agents. *Educational Technology*, 47(1), 56-61.
- Campbell, P.B., Honey, E.J. and Perlman, L.K. (2004). Upping the Numbers: Using Research Based Decision on Making to Increase Diversity in the Quantitative Disciplines. G.E. Foundation Report.
- Catsambis, S. (2003). The Path to Math: Gender and Racial-Ethics Differences in Mathematics Participations from Middle School to High School. *Sociology of Education*.
- Corno, Y. (2006). Effect of Field Dependent-Independent Cognitive Styles and Cueing Strategies on Students Recall and Comprehension. Unpublished Doctoral Dissertation. Virginia Polytechnic Institute, Blacksburg, V.A.
-

- Cracker, D.O. (2006). Attitudes Toward Science of Study Enrolled in Introductory Level Science Courses at UW-La Crosse, UW-L
Journal of Undergraduate Research IX: 1-6.
- Daniel, E, and Reid, N. (2006). Cognitive Factors That Can Potentially Affect Pupils Test Performance. *Chemistry Education Research and Practice.*
- DeJong, T. & Van Joolingen, W. (2003). Scientific Discovery Learning with Computer Simulations of Conceptual Domains. *Review of Educational Research, 68, 2:179201.*
- Donald R. Cruickshank, (2003). Uses and Benefits of Reflective Teaching. *The Phi Delta Kappan. Vol. 66 (10), pp. 704-706.*
- Fisher, D. & Frey, N. (2009). *Background Knowledge: The Missing Piece of the Comprehension Puzzle*, Portsmouth, HN: Heinemann.
- Garba, R.B. (2004). Teachers Classroom Control and Students Academic Achievement (Unpublished M.Ed Dissertation). University of Ilorin, Ilorin.
- Hall, J. and Saunders, O. (2003). *Adopting a Student-Centred Approach Management of Learning*, London: Kogan.