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EFFECT OF PAPER – AND – PENCIL CONCEPT MAPPING STRATEGY ON THE ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL PHYSICS STUDENTS IN RIVERS STATE

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Abstract
Low level achievement of secondary school Physics students' has been widely reported and the instructional strategy used by the Physics teacher has been implicated to be the major cause of this low achievement. Hence, the need to determine the effect of paper-and-pencil concept mapping strategy on the academic achievement of secondary school Physics students' in Rivers State. The study adopted the qausi-experimental research design using pre-test and post-test treatment and control groups. Purposive sampling technique was employed to obtain a sample of 130 Senior Secondary Two Physics students from Community Secondary School (C.S.S) Omoku. The Sample consists of 78 males and 42 females. The instrument was the Physics Achievement Test (PAT) to measure students' achievement. The instrument was pilot tested to ascertain reliability. The reliability coefficient was 0.92 using Kuder-Richardson Formula 21. Three research questions and three hypotheses were formulated and tested at 0.05 level of significance. Data was analyzed using t-test. Findings revealed that there is a significant difference in the academic achievement of students' taught using paper-and-pencil concept mapping strategy. Also, there was no significant effect of gender on the achievement of Physics students taught using concept mapping strategy, but on the achievement of Physics students taught without concept mapping, there was significant effect of gender. Therefore, it was recommended that the Government, Curriculum planners, textbook writers, administrators and teachers should introduce the use of concept mapping strategy in the teaching and learning of Physics in secondary schools in Nigeria to improve students achievement in Physics.

Keywords: *Academic achievement,concept map, instructional strategy , paper-and-pencil*

Introduction

Science education is indispensable when it comes to a nation's self-reliant and her ability to contend with other developed nations. This goes to show that science education is the key to the development of any nation scientifically and technologically (Alebiosku & Michael, 2011). It is largely accepted that, scientific literacy which aid the existence of a nation in terms of scientific and technological knowledge can only be achieved through science education.Like all other governments in the world, the Nigeria

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government fully comprehends the roles of science and technology in issues of national development. This is manifest in the statement of the goals of science education in the National Policy of Education;

1. Cultivate inquiring, knowing and rational mind for the conduct of a good life and democracy;
2. Produce scientists for national development;
3. Service studies in technology and the cause of technological development;
4. Provide knowledge and understanding of the complexity of the physical world, the forms and the conduct of life (Federal Republic of Nigeria, 2004).The Federal Republic of Nigeria (2004), while stressing the place of science and technology for the country's national developmental agenda states that "a greater proportion of expenditure on education shall be devoted to science and technology". Furthermore, the document affirmed that at each level of the nation's education system, separate provisions as well as motivations shall be made available for the learning of the sciences. For this goal, the government shall fully support the roles of all agencies that have to do with the advancement of the study of science and that: Government, for the sake of national development shall propagate and stimulate the effective production of satisfactory number of scientists. As a method of placing the above goals of the Nigeria government into reality, the FRN (2004) in the National Policy on Education states explicitly that "not less than 60% of places shall be allocated to science and science oriented courses in the conventional universities while 40% shall be allocated to the arts and social science courses." The motive for this is to take Nigeria into the technological age so as to excite the growth of the nation through the use of her natural resources with the aid of knowledge gotten from science education.

But this has produced no pleasing outcome considering the declining trend of the number of students seeking admission into the sciences in our Nigerian institutions. Statistics available by West African Examination Council (2010) showed that performance of students in sciences in the May/June examination has been on the decline. The data showed that on the average only 22.6% of the students which sat achieved credit level pass and above in the science while 45.49% failed out rightly. Also the research carried out by Ainna and Ayodele (2018) on "The Decline in Science Students Enrolment in Nigerian Colleges of Education" shows a decline in the number of enrolment between 2014 to 2016 in College of Education Technical, Lafiagi, Kwara State, Nigeria as shown below;

Table 1. Science student's enrolment between 2014 and 2016 in College of Education, Lafiagi, Kwara State.

Year	Biology	Chemistry	Physics
2014	547	196	124
2015	335	86	58
2016	217	55	19

Source: Aina & Ayodele (2018)

Data collected from the Directorate of Degree Program, Federal College of Education (Technical) Omoku, Rivers State, also shows a decline in the number of enrolment of Science Students between 2018 to 2021, as shown below

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Table 2. Science student's enrolment between 2018 and 2021 in F.C.E.(T), Omoku, Rivers State.

Departments	2018/2019	2019/2020	2020/2021	Total
Mathematics	10	8	5	23
Biology	36	42	34	112
Physics	5	-	1	6
Chemistry	8	11	6	25
Computer	14	32	26	72

Source: Directorate of Degree Program, F.C.E.(T), Omoku (2022)

Oludipe (2011) notes that the reason for the low enrollment of students into the sciences, could be as a result of how they were taught science during their secondary level education. In Nigeria, Physics is one of the sciences a student must learn at the secondary school level and it grooms the students at this secondary school level for better performance of the sciences at the tertiary level (Oludipe, 2014). The effect is that, without proper grooming of the students in physics at the secondary school level, they would not be competent to study science-oriented courses in the nation's tertiary institutions. Notwithstanding the importance of Physics in the study of science and technology, the performance of students in the study of Physics has been termed to be poor (Ochu & Haruna, 2015). Furthermore, the researcher states that this poor achievement in Physics repudiates many students chance of gaining admission into Universities, Polytechnics and Colleges of Education to study venerated science – oriented courses. According to Ochu and Haruna, (2015), inadequate elementary knowledge in Basic science and Technology, as well as Mathematics makes students to shift to non-science oriented courses emanating to low enrolment of students as well as turnover in the sciences, thereby producing a vacuum in the growth and development of the nation.

Research report also makes known that student's low performance in Physics is as a result of a number of reasons of which the Physics teacher's instructional strategy is crucial. Eze and Bot (2014) noted that learning objective is affected by the choice of instructional strategy used by the Physics teacher; it is the single element that the Physics teacher can simply manipulate to realize stated aims and objectives. Etukudo (2002) in his study affirmed to the fact that instructional strategies used and implemented by the teacher arouse learners' recall ability in general mathematics and sciences. The contents of the Physics curriculum have been structured in a way that each section reoccurs each year, that is, in a spiral form. This is to enhance the recall ability of the learners and ultimately produce better achievement in there learning of Physics. Mathematics is used to make clear the Physics objectives (NERDC, 2008). The curriculum also underscores the shift from the behaviorism to constructivism to enrich the learning of Physics concepts and to stimulate attitudes of learners in Physics (NERDC, 2008). Furthermore, the curriculum makes the Physics teacher a facilitator while the learners are the center of the classroom activity, which include the learners' ability in their construction of knowledge.

The teaching of science has to be made very interesting to the learner otherwise interest is lost. The teacher has to take it upon himself to make changes in the teaching and learning of science to accommodate the changing world (Wang, 2005).

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The traditional approach has been used by many teachers to teach science. For them, it is the ideal way to teach and learn science. Nonetheless, for the interest of the learners to be sustained, the teacher must use different strategies to achieve the stated objectives and leading to improved performance of the learners. Teaching strategies refers to the methods, techniques, procedures and processes that a teacher uses during teaching and learning to make the learning more effective. Tamang (2004) In his research on "Strategies for Teaching Physics," listed ten strategies to teach Physics. Furthermore, Wang (2005) in his paper, "Using new strategies to improve teaching and learning in Fundamental Physics course" listed four strategies in teaching physics of which concept mapping is one of them. In this research, certain inevitable situations relating to time and resources did not allow the authors to do exhaustive study on all the strategies for teaching and learning of physics. Nevertheless, selected strategies are examined below.

i.Collaborative learning**:** in this learning strategy, learners work in groups of two or more, jointly searching for understanding, solutions, or meanings, or creating a product. Collaborative learning has benefited the learners of Physics, as it develop in them self-confidence and higher-level thinking skills. (Sibley & Ostafichuk, 2015).

ii.Blended learning: this is a learning strategy that utilized both online and in-person learning experiences when teaching the physics students. The students after the traditional classroom methods, complements the learning with online educational materials and opportunities for interaction online.

iii.Computer aided learning: is a learning strategy in which computer program is used to assist the Physics student in learning. It allows the students to have an active role in the teaching and learning process. And further provides the teachers with more options to teach and more time to evaluate progress of activities.

iv.Demonstration and investigation**:** Physics is a subject that requires step by step explanation and demonstration. Demonstrating the skills and allowing learners rehearsal will have a lifelong effect on learners' achievement while investigation is also carried out by the Physics student leading to discoveries and better understanding of the Physics concepts.

v.Using diagrams to solve questions**:** This strategy is helpful to solve problems as well as for explanations during teaching and learning. The use of diagrams makes the problem to be solved more concrete than abstract, thereby leading to better comprehension and solved problems.

vi.Using acronyms to improving speed of learning and retention**:** Those learners, who struggle in understanding long statements, learn quicker and better when shorter forms of statements are used. This strategy could be used to teach various laws, principles, hypotheses, equations and explanations.

vii.Application base approach**:** Physics is a subject which has an all-round application in daily life. Here the learner is made to learn by making him see the application of the subject in real world experience. (Jatsho & Rinchen, 2016).

viii. Concept map (paper-and-pencil): is a technique of graphic organization of structure of information, concepts and their relationship using paper and pencil. They can take the form of charts, graphic organizers, tables, flowcharts, Vann diagrams, or timelines. Paper and pencil concept mapping strategy is especially useful for students who learn better visually, although they can benefit any type of learner. Concept maps identify the way the students think and the way they see relationships between knowledge. (Novak & Canas, 2006).

Concept mapping (paper-and-pencil) is a technique of graphic organization of structure of information, concepts and their relationship (Novak & Canas, 2006; Novak, 2010). Concept Maps are

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usually prepared using cross links. The concepts are commonly presented inside a square and the cross link phrases label the lines or arrows which join up two or more concepts. The concepts are the subject matter of the phrases (nouns or adjective) and the cross links tend to contain verbs and prepositions. The most common theories involved in making and using of concepts maps have its place in the field of Cognitive Psychology. Concept maps are multipurpose and malleable tools which have been useful for varying purposes such as consolidation of learning techniques, evaluating learners, supporting creativeness in writing (critical thinking), reading comprehension, and interchanging ideas in work groups. It is, nevertheless, in the practices of teaching and learning that we come across the enormous bulk of literature in this field. (Adesope & Nesbit, 2013; O'Donnell et al., 2002).

Statement of the Problem

One of the challenges faced in the study of Physics education is poor performance (Isola, 2010). Different researches have been conducted on performance of students in Physics, and teaching strategy adopted by the Physics teacher seems to be the main challenge (Duru, 2007; Eze & Bot, 2014). Nonetheless, Physics teachers have used numerous strategies like jigsaw, inquiry teaching strategy, collaborative learning strategy, problem – solving strategy among others for teaching of Physics, yet poor achievement is still been recorded (Adeniran et al., 2008). Following the poor recall ability and performance in internal and external examinations of Physics students, there is an outcry from all concern (parents, teachers, curriculum planners, and other stakeholders) for better performance. It is on this premise that the researcher seeks to determine the effect of Paper – and – Pencil Concept Mapping Strategy on the academic achievement of secondary school Physics students in Rivers State.

Purpose of the Study

The purpose of this study is to investigate the effect of Paper – and – Pencil (PAP) concept mapping strategy on the academic achievement of secondary school physics students in Rivers State. The study strives to achieve the following objectives which are to;

1. Find out the difference in the mean achievement scores of Physics students taught using paper-and-pencil concept mapping strategy and those taught using conventional method.
2. Determine the difference in the mean achievement scores of male and female Physics students taught using paper-and-pencil concept mapping strategy.
3. Ascertain the difference in the mean achievement scores of male and female Physics students taught using conventional method (without concept map).

Research Questions

The following research questions guided the study:

1. What is the difference in the mean achievement scores of Physics students taught using paper-and-pencil concept mapping strategy and those taught using conventional method?
2. What is the difference in the mean achievement scores of male and female Physics students taught using paper-and-pencil concept mapping strategy?
3. What is the difference in the mean achievement scores of male and female Physics students taught using conventional method (without concept map)?

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Hypotheses

The following research hypotheses were formulated to guide the study;

Ho_1: There is no significant difference in the mean achievement scores of Physics students taught using Paper-and-Pencil concept mapping strategy and those taught using conventional method.

Ho_2: There is no significant difference in the mean achievement scores of male and female Physics students taught using Paper-and-Pencil concept mapping strategy.

Ho_3: There is no significant difference in the mean achievement scores of male and female Physics students taught using conventional method (without concept map).

Research Instrument and Method of Study

The design for this study is quasi-experimental research design, which lacks certain methods of control of variables. It is made up of treatment group and control group. The treatment group was taught differently from the control group. Purposive sampling technique was used to obtain 10 percent (130 students) of the population (1,300 students). The 130 students were selected from Community Secondary School (C.S.S) Omoku in Ogba/Egbema/Ndoni Local Government Area of Rivers State. The selected school is among those currently presenting candidates for the Senior Secondary School Certificate Examination (SSCE). The selected students were actually those in Senior Secondary Two (S.S.2). They were considered based on the fact that most of them have learnt Physics in their S.S.1, and they have better stand to provide the necessary information needed for this work. The treatment group (those taught using concept map) consist of 64 students (45 males and 19 females) while the control group (those taught without concept map) consist of 66 students (33 males and 33 females).

The instrument used for this study was titled "Physics Achievement Test (PAT)". A total of Thirty (30) objective test items were constructed on the topic: Newton's Laws of Motion, by the researcher and were administered to both set of groups. The instrument was face and content validated by three experts in measurement and evaluation. The thirty (30) multiple choice test items were administered to a trial testing group of twenty – four (24) S.S.2 students selected from a Senior Secondary School in ONELGA who were not part of the main study but who were found to be equivalent in all respects to the students in the study. The results obtained in this administration were subjected to Kuder – Richardson's formula – 21. The result showed reliability co-efficient of 0.92. On the basis of the high reliability index the instrument was deemed suitable to be used in conducting the research

The research instrument consisted of thirty (30) objective questions with three (3) distracters and one correct option letter A – D. The test instrument was administered to both set of students by the researcher in the classroom for a period of one hour. It was collected immediately after the test by the researcher. The researcher scored the instrument immediately after its administration. Each correct answer was scored two (2) marks. The total (maximum) mark for all the thirty (30) test items was sixty (60) and the minimum was zero. The test was repeated after the treatment of both groups.

Results

The result of the Physics Achievement Test (PAT) was analyzed using mean and independent sample t-test at 0.05 level of significance to test the hypotheses. The critical value is 1.98, for 128 degree of

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freedom. Decision making was based on; Reject the null hypothesis (H_O) if the t – calculated is greater than critical value, otherwise do not reject.

Research Question 1: What is the difference in the mean achievement scores of Physics students taught using paper-and-pencil concept mapping strategy and those taught using conventional method?

Table 3. Showing mean achievement scores of Physics students taught using paper-and-pencil concept mapping strategy and those taught without.

	Treatment Group (N = 64)		Control Group (N = 66)	
	Mean ($\bar{x}$)	S.D	Mean ($\bar{x}$)	S.D
Pre – test	15.47	7.21	13.64	6.17
Post – test	29.75	6.45	22.67	6.46
Mean gain score	14.28		9.03	

Table 3. shows that students in treatment group obtained a mean score of 15.47 in the pre – test and 29.75 in post – test and a mean gain score of 14.28. On the other hand, the students in control group had mean scores of 13.64 and 22.67 as pre – test and post – test respectively and had a mean gain score of 9.03. This underscore that the students in the treatment group achieved higher than those in the control group in the Physics achievement test. To confirm whether the observed difference in the two groups was significant or not, hypothesis I, was tested.

Research Question 2: What is the difference in the mean achievement scores of male and female Physics students taught using paper-and-pencil concept mapping strategy?

Table 4: Showing mean achievement score of male and female Physics student taught using paper-and-pencil concept mapping strategy (PAP).

	Male (N = 33)		Female (N = 33)	
	Mean ($\bar{x}$)	S.D	Mean ($\bar{x}$)	S.D
Pre – test	13.27	5.74	14.00	6.36
Post – test	21.64	5.61	23.70	6.77
Mean gain score	8.37		9.70	

Data displayed in table 4, indicates that male in treatment group had a mean score of 15.56 in the pre – test and 30.00 in post – test; and a mean gain score of 14.44. On the other hand, the female in the treatment group had the mean scores of 15.26 and 26.95 as pre – test and post – test respectively and had a mean gain score of 11.69. This shows that the male students achieved higher than their female counterparts in the treatment group in the Physics achievement test. To confirm whether the observed difference in the achievement between the two groups (male and female) was significant or not, hypothesis 2 was tested.

Research Question 3: What is the difference in the mean achievement scores of male and female Physics students taught using conventional method (without concept map)?

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Table 5: Showing mean achievement score of male and female Physics student taught using conventional method (without concept map).

	Male (N = 45)		Female (N = 19)	
	Mean ($\bar{x}$)	S.D	Mean ($\bar{x}$)	S.D
Pre – test	15.56	6.85	15.26	7.15
Post – test	30.00	6.54	26.95	6.58
Mean gain score	14.44		11.69	

Data displayed in table 5 indicates that male in control group had a mean score of 13.27 in the pre – test and 21.64 in post – test; and a mean gain score of 8.37. On the other hand, the female in the control group had the mean scores of 14.00 and 23.70 as pre – test and post – test respectively and had a mean gain score of 9.70. This shows that the female students achieved higher than their male counterparts in the control group in the Physics achievement test. To confirm whether the observed difference in the achievement between the two groups (male and female) was significant or not, hypothesis 3 was tested.

Hypothesis 1: There is no significant difference in the mean achievement scores of Physics students taught using paper-and-pencil concept mapping strategy and those taught using conventional method.

Table 6: showing independent sample t – test of significant between Physics students taught using paper-and-pencil concept mapping strategy and those taught without.

Variable	Mean	SD	N	t-cal	t-crit	Decision
Male	30.00	6.54	45	1.70	1.98	Accept H_{01}
Female	26.95	6.58	19			

$P < 0.05$

Since the calculated t – cal (1.70) is less than the critical value (1.98), the null hypothesis is thus accepted. Therefore, there is no significant difference in the mean achievement scores of male and female students in treatment group.

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students taught Physics using paper-and-pencil concept mapping strategy.

Table 7: Showing independent sample t – test of significant between male and female Physics students taught using paper-and-pencil concept mapping strategy.

Variable	Mean	SD	N	t-cal	t-crit	Result
Treatment Group	29.75	6.45	64	6.21	1.98	Reject
Control Group	22.67	6.46	66			H_{02}

$P < 0.05$

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Since the calculated t – cal (6.21) is greater than the critical value (1.98), the null hypothesis is thus rejected. Therefore, there is a significant difference in the mean achievement scores of Physics students taught using concept mapping (PAP) strategy and those taught using conventional method.

Hypothesis 3: There is no significant difference in the mean achievement scores of male and female students taught Physics using conventional method.

Table 8: Showing independent sample t – test of significant between male and female Physics students taught using conventional method.

Variables	Mean	SD	N	t-cal	t-crit	Result
Male	21.64	5.61	33	5.52	1.98	Reject H_{03}
Female	23.70	6.77	33			

$P < 0.05$

Since the calculated t – value (5.52) is greater than the critical value (1.98), the null hypothesis is thus rejected and the alternative hypothesis upheld. Therefore, there is a significant difference in the mean achievement scores of male and female students in control group.

Discussion of Findings

The study set out to investigate the effect of Paper-and-Pencil concept mapping on the academic achievement of Physics students. The study showed that concept mapping strategy improves student's achievement in Physics, as can be understood from the data analysis in table 3. Furthermore, test analysis in table 6 shows that the achievement of students in the treatment group was significant with calculated t – value of 6.21 at $P < 0.05$. Hence the null hypothesis was rejected. This denotes that students taught Physics using concept mapping strategy outweighed their opposite number in their achievement who were taught using conventional method. The outcome of this study is in agreement with that of Fatokun and Eniayeju (2014) who in their study found out that students taught with concept mapping strategy achieved better than those taught using conventional method. This is because through concept mapping strategy, students are knowledgeable to organize concepts and their relationship in well-ordered manner leading to a better and improved achievement. Therefore concept mapping should be embraced for the teaching of Physics in our secondary schools.

The result in table 4 indicated that to some extend the achievement scores of male and female students differed after being taught Physics using concept mapping strategy. This difference was further tested as shown by the analysis in table 7, showing a calculated t – value of 1.70 which is less than the critical value of 1.98, the null hypothesis of no significant difference was thus, accepted. This proves that the difference in the mean achievement scores of male and female students taught Physics using concept mapping strategy was not statistically significant. The result put forward here agrees with Orora et al., (2007), who found that the achievement of male students as compared to their female counterparts was improved after being taught using concept mapping strategy. Researchers come to an understanding that, it is because female do not have the propensity to recall diagrams as much as the males do and concept maps requires connecting concepts to drawings. Nonetheless, Ukapi et al., (2016) found no

difference that is noteworthy in the academic achievement of male and female Physics students after being taught using concept mapping strategy.

The data presented in table 5 showed that the achievement scores of male and female students in the control group differ slightly after being taught Physics without concept map. To see if this difference was significant, hypothesis 3 was tested and the data analysis in table 8 showed a calculated t – value of 5.52, which is greater than the set critical value of 1.98. The null hypothesis of no significant was, therefore rejected. This implies that, there is statistical substantial difference in the mean achievement scores of male and female students taught using conventional method. The result presented here agrees with those of Zember and Blume (2011) who spelled out that females rather than males achieve better in school. But differ from those of Akinbobola (2004), Abubakar and Oguguo (2011) and Uduosoro (2011) who put forward that in the academic performance of Physics students, the effect of gender was not significant.

Conclusion

The findings of the study asserts that paper-and-pencil concept mapping strategy enhance students' academic achievement in senior school Physics in Community Secondary School (C.S.S) Omoku. Students who were taught using concept mapping strategy achieved higher than those taught without concept mapping strategy. This underscores that the students in the treatment group had a better understanding of the concept and principles taught than their counterparts in the control group. Therefore, students, teachers, school administrators, curriculum planners, textbook writers, parents and the government all need to be aware of the effect that concept mapping strategy have on the academic achievement of students.

Recommendations

From the findings of this research, the following recommendations are given:

1. Federal and State Ministries of education should make reforms to enhance the use of concept mapping strategy in our secondary schools.
2. Curriculum developers should incorporate concept mapping strategy as one of the strategies for teaching and learning of Physics for better learning outcome.
3. Examination bodies and textbook writers should include concept mapping as an evaluative tool on their examinations.
4. School administrators and teachers should use concept mapping in their classroom teaching and learning for better learning outcome.
5. Pre – service and in service teacher education programs should incorporate concept mapping strategy in the curriculum to prepare teachers with respect to its philosophical and theoretical base and practical usage.

References

Abubakar, R. B., & Dokubo, O. O. (2011). Age and gender as creditors of academy achievement of college mathematics and science students. *Journal of Educational and Social Research*, 1(2), 89-94

Cite this article as
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Adeniran, S. A., Ochu, A. N. O., & Atoo, S. F. (2018). Effect of concept mapping strategy on students' retention in basic science in Benue state, Nigeria. *International Journal of Research and Review. 2018, 5*(5),193-200.

Adesope, O. O., & Nesbit, J.C. (2013). "Animated and static concept maps enhance learning from spoken narration". *Learning and instruction*, 27, 1-10. http://dx.doi.org/10.1016/j.learninstruc.2013.02.002

Aina, J. K., & Ayodele, M. O (2018). The Decline in science students' enrolment in Nigeria Colleges of Education: Causes and Remedies, *International Journal of Education and Practice, 6*(4),167-178.

Alebiosku, K., & Michael, E. (2011). Concept mapping teaching strategy and secondary students attitude to physics in Ibadan, *Nigeria Journal of the African Education Research, 2*(1) ,55-62.

Akinbobola, A.O. (2004). *Effective science teaching Milton Keynes*, Open University Press.

Directorate of Degree Program (2022). *Students Handbook*. University of Nigeria Nsukka Press.

Etukudo, U.E. (2002). The effect of computer-assisted instruction on gender and performance of junior secondary school students in Mathematics. *Abucus Journal of Mathematics Association of Nigeria, 27*(1), 1-8.

Eze, J.E, & Bot, T.D. (2014). Effect of concept mapping on secondary school students' achievement in Mathematics in Bichi Education zone, Kano State. *African Journal of Arts, Science and Educational issues, 2*(2), 45-56.

Fatokun, K. V. F., & Eniayeju, P. A. (2014). The effect of concept mapping-guided discovery integrated teaching approach on chemistry students' achievement and retention. *Academic Journal, 9*(22), 1218-1223.

FRN (2004). *National Policy on Education.* NERDC Press.

Isola, O. M. (2010). Effect of standardized and improvised instructional material on students' academic achievement in secondary school Physics. M.Ed Thesis. University of Ibadan, Luowi, U.M.O (1997). Redesigning school curricula in Nigeria, WCCL region 2 seminar, NERDC Conference center, Lagos 2.21.

Jatsho, S., & Rinchen, S. (2016). Strategies for teaching Physics: An Action Research. Educational Innovation and Practice *.A biannual Journal of Samtse College of Education, 1*, 53-66.

NERDC (2008). *The new senior secondary school curriculum structure at a glance*. Federal Ministry of education.

Novak, J.D. (2010). Learning, Creating and Using knowledge concept maps as facilitative tools in schools and corporations. *Journal of e-learning and knowledge society, 6*(3), 21-30.

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CC-BY-NC-SA 4.0 International Print ISSN : 2971-6624 eISSN: 2971-6632

Novak, J. D. & Cañas, A. J. (2006). "La teoría subyacente a los mapas conceptuales y cómo construirlos".http://cmap.ihmc.us http://www.cs.northwestern.edu/~paritosh/papers/sketchto-models/Novak-Canas-TheoryUnderlyingConceptMapsHQ. Pdf

Ochu, A. N. O, & Haruna, P. F. (2015). Challenges and Prospects of creativity in a Basic Science teacher. *British Journal Of Education, Society And Behavioral Science*, *5*(2), 237-243.

O'Donnell, A. M., Dansereau, D. F. & Hall, R. H. (2002). "Knowledge maps as scaffolds for cognitive processing". *Educational psychology review.* http://dx.doi.org/10.1023/A:1013132*527007*

Oludipe, D. T. (2011). Developing Nigeria Integrated science curriculum. *Journal of science and environmental management, 2*(8), 134-145.

Oludipe, D. I. (2014). Gender and Science anxiety as predictors of Basic Science. *Scholars Journal of Arts, Humanities and Social Science, 2*(2A), 197-203.

Orora, W., Wachanya, S. W., & Keraro, F. N. (2007). Effect of cooperative concept mapping teaching approach on secondary school students' achievement in Biology in Gucha District, Kenya, *Zimbabwe Journal of Education Research, 3*, 1-18.

Sibleg, J., & Ostafichuk, P. (2015). *Getting started with team-based learning*. Stylas Publishing, LLC.

Tamang, M. (2004). Strategies for teaching physics. *Rabsel-Center for Educational Research and Development, 4*, 34-45.

Uduosoro, U. J. (2011). The effect of gender and mathematics ability on academic performance of students in chemistry. African. *Research Review*. www.Ajol.into/index.phb/Alrrev/article/view/592077.

Ukpai, P. O., Okafor, G., Abonyi, O., & Ugama, J. O. (2018). Effect of concept mapping instruction approach on students' achievement in Basic Science. *Journal of Education and Practice, 7*(8), 79-84.

Wang, L. (2005). Using new strategies to improve teaching and learning fundamental physics course. http://science.uniserve.edu.au/pubs/china/vol5/CP5_phys_01.pdf

West African Examination Council (2010). *May/June Chief Examiner's Report*.WAEC

Zembar, L. B., & Blume, L. B. (2011). Gender and academic achievement. www.education.com/Refrence/Article/Genderfoacademytoachievement/

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