

EFFECTIVENESS OF CONTEXTUAL INSTRUCTIONAL MODELS ON THE ACADEMIC ACHIEVEMENT AND KNOWLEDGE RETENTION OF SECONDARY SCHOOL PHYSICS STUDENTS IN MOTION

¹KINGSLEY T. ONAH, ²CHARLES U. EZE & ³DONALD IKENNA UNAMMA

^{1&2}Department of Science Education, Enugu State University of Science and Technology, P.M.B. 01660, Agbani, Enugu State, Nigeria.

³Department of Physics, Federal University Otuoke
1kingsley.onah@esut.edu.ng & 3unammadik@fuotuo.ke.edu.com

Abstract

The abysmal performances amongst physics students have raised pertinent questions amongst stakeholders. This study therefore investigated the effectiveness of contextual instructional models on students' achievement and knowledge retention in motion. The study was guided by six research questions and six null hypotheses. Quasi-experimental research design was employed. 1,587 students were targeted for the study with a sample of 105 students purposively sampled. The study adapted an instrument tagged MAT from WAEC past questions. Three experts validated the instrument; the internal consistency reliability of the instrument was measured using Kuder-Richardson-20 due to its dichotomous nature with index of .81. Mean, standard deviation and ANCOVA were used to answer the research questions and hypotheses respectively. SPSS version 23 was used. The findings amongst others revealed CIM improved achievement and knowledge retention of Physics students more than TLM. It was recommended that Educators should be encouraged to integrate real-world problems and scenarios into their pedagogical approaches to make physics more accessible and engaging.

Keywords: Contextual instructional models, Physics, Motion, Achievement, Knowledge retention

Introduction

Physics is the root to knowing the natural world around us. Physics is defined as a branch of science that deals with the study of matter and its relationship with energy in an observable environment. In the words of Onah, Anamezie and Nnadi (2022), Physics is the study of systematized knowledge produced through observation, measurement and experiment which attempts to establish general laws or principles to describe the phenomena under study. Physics is a methodological study of nature through observation, reason and mathematical analysis. Physics helps to understand the fundamental building block of the universe and how nature interacts to produce energy. Physics is broadly categorized by two major frameworks as classical physics and modern physics. The branches of Classical Physics include motion, mechanics etc. Motion is the rate at which objects or bodies move.

The study of a moving body without regard to what makes it move is referred to as kinematics. Again, Dynamics studies the moving body in relation to what makes it to move. Force is responsible for a moving body. Therefore, kinematics entails speed, velocity, acceleration and relative speed. According to Onah, Anamezie and Nnadi (2022), the knowledge of kinematics is in relation to all moving bodies including vehicles. Dynamics introduces the concepts of force, mass, momentum, and energy (including concepts like Newton's Laws of Motion) to establish a cause-and-effect relationship for all physical changes. This is arguably the most powerful concept in classical physics. Kinematics and dynamics provide the mathematical framework for understanding change, causality, and predictability in the physical world, making them indispensable to all branches of science and engineering.

Despite the critical role of motion in physics and understanding of science, students' achievement in the content remain generally poor. Academic achievement refers to a student's current academic status as demonstrated by their grades, performance on an educational achievement examination, and cumulative indicators like degrees and certificates. In the context of this work, academic achievement is taken as the student's overall performance in the external WASSCE and/or NECO examinations (Onah & Anamezie, 2022). In addition, during the May/June 2025 SSCE. A total of 1,969,313 candidates took physics in the said examination, of this figure 754,545 (38.32%) passed between Alpha and Credit, and 61.68% made F9 grade. National examination reports indicate a growing decline in students' achievement which engendered poor knowledge retention in physics concept of motion.

Knowledge retention refers to the ability to remember or utilize already acquired knowledge or skills. It also refers to skill or knowledge or competences a learner acquired and retained from a learning situation after forgetting has taken place (Ezeano, 2018). It is the ability to remember something, skills, knowledge, habits, attitudes or other responses initially acquired. Retention plays an important role for what is learned to be effectively applied. Poor retention can hinder students' ability to apply their knowledge and skills, ultimately impacting their academic success and overall learning (Fisher & Radvansky, 2018). According to Onah, Anamezie and Nnadi (2022), this unacceptable learning outcomes exhibited by the students strictly arouse from the blamable lecture instructional methods used by physics teachers.

Traditional lecture method is a type of instruction that uses talk-chalk pedagogy to effectively impart thoughts and ideas to the students. Lecture method places a strong emphasis on textbooks and workbooks for curriculum exercises. Even when learners don't grasp the key ideas, the majority of teachers still follow it (Ibe & Abonyi, 2015). The traditional lecture method uses an expository approach to teaching, which does bias students toward hands-on learning activities but rather piques their curiosity about science and the teaching process that foster forensic learning of physics (Achufusi-Aka & Okpanachi 2021). Contextual instructional models relate physics concepts to real-world situations. These are increasingly recognized for their potential to improve student achievement and knowledge retention (Liu & Lee, 2020).

Contextual instructional models (CIM) are simply the representation of diagram, animation, analogy, simulation, charts and physical materials that links contents to the real-world situation. Quantities (position, velocity, acceleration, force) to phenomena students are familiar with. The goal is to bridge between Physics teaching and real-life situation. Contextual instructional models aid teachers to connect academic concepts to practical situations in the learning paradigm. It encourages pupils to draw links between their academic understanding and practical applications (Lotlung, Ibrahim & Tumurang 2018). Numerous studies in the fields of cognitive science and comparable behavior theory have endorsed the CIM and other learning models (Setiawati 2018, Sarwinda 2020, Setiawati, Ramadhan & Gani 2018). Constructivism posits that learners actively construct knowledge through meaningful experiences (Piaget, 1952).

Contextual models align with this theory by situating physics concepts within familiar contexts, enabling students to relate new knowledge to prior knowledge. CIM emphasizes real-world application and contextual relevance to foster engagement, understanding and retention (Chen & Tsai, 2012). It enables students to connect physics principles with everyday life, thus improving knowledge retention and achievement. Studies show that contextual instructional models positively influence students' understanding of physics concepts (Taber, 2013). For example, a study by Taber (2013), found that students exposed to real-world problems demonstrated higher test scores in motion than those in traditional classrooms. Understanding motion principles, such as velocity, acceleration, and force,

benefits from contextual approaches because they exemplify these principles in tangible settings (Cakmak & Karamustafa, 2014). An experimental study by Akten and Acar (2019) demonstrated that students exposed to contextual learning models scored significantly higher on motion assessments compared to control groups taught with conventional methods. This model seeks to navigate gender disparity in physics.

Gender is a stereotype of social order of man and a woman in the contest of education. According to World Health Organization (2020) on gender and health, gender is referring to the characteristics of women, men, girls and boys that are socially constructed. This includes norms, behaviour and roles associated with being a woman, man, girl or boy, as well as relationships with each other. Gender has been noted by researchers over the years as having an impact on students' achievement in Physics and its related disciplines (Onah, Anamezie & Nnadi, 2022). Nwankwo and Okoye, (2015) opined that gender has no influence on students' achievement in the sciences. Due to lack of consensus regarding the issue of gender and science and more importantly to capture the interest of boys and girls, and consequently improve their achievement and knowledge retention in physics and other science-related carriers.

Objectives of the Study

In line with the problems of the study, the main purpose of the study is to investigate the effectiveness of contextual instructional models on students' academic achievement and knowledge retention in motion. Specifically, the study sought to find the:

1. Mean achievement and standard deviation scores of students taught motion using CIM and those taught using TLM.
2. Mean achievement and standard deviation scores of male and female students taught motion using CIM and those taught using TLM.
3. Interaction effect of teaching approaches and gender on students' achievement in motion. Mean knowledge retention and standard deviation scores of students taught motion using CIM and those taught using TLM.
4. Mean knowledge retention and standard deviation scores of male and female students taught motion using CIM and those taught using TLM.
5. Interaction effect of teaching approaches and gender on students' knowledge retention in motion.

Research Questions

The following research questions were designed to guide the study.

1. What is the mean achievement and standard deviation scores of students taught motion using CIM and those taught using TLM?
2. What is the mean achievement and standard deviation scores of male and female students taught motion using CIM and those taught using TLM?
3. What is the Interaction effect of teaching approaches and gender on students' achievement in motion?
4. What is the mean knowledge retention and standard deviation scores of students taught motion using CIM and those taught using TLM?
5. What is the mean knowledge retention and standard deviation scores of male and female students taught motion using CIM and those taught using TLM?
6. What is the Interaction effect of teaching approaches and gender on students' knowledge retention in motion?

Hypotheses

The following null hypotheses were formulated for the study; which was tested at 0.05 level of significance

HO1: There is no significant difference in the mean achievement scores of students taught motion using CIM and those taught using TLM.

HO2: There is no significant difference in the mean achievement scores of male and female students taught motion using CIM and those taught using TLM.

HO3: There is no significant interaction effect of gender and teaching methods on students mean achievement scores in physics.

HO4: There is no significant difference in the mean knowledge retention scores of students taught motion using CIM and those taught using TLM.

HO5: There is no significant difference in the mean knowledge retention scores of male and female students taught motion using CIM and those taught using TLM.

HO6: There is no significant interaction effect of gender and teaching methods on students mean knowledge retention scores in physics.

Methodology

A pretest-posttest quasi-experimental research design, specifically non-equivalent control groups design was adopted for the study. A pretest-posttest quasi-experiment is an experiment where randomization assignment of subjects to experimental and control groups is not possible (Nworgu, 2018). The design was considered appropriate for the study because intact classes were used to avoid disruption of normal class lesson. The study was done in Enugu Education Zone. The researchers chose Enugu Education Zone because they observed that teachers have continued to use same lesson plans/ notes over and over again resulting to students' mass failure in their external examinations. The lesson plans are designed for students to continue to engage in rote learning; hence the need for the study in the area.

The population for the study was 1,587 SS 2 students from Enugu Education Zone. One hundred and five (105) SS 2 physics students (53 males & 52 females) drawn through purposive sampling technique from two co-educational secondary schools in Enugu East Local Government Area of Enugu State were used for the study. Purposive sampling was used to select two co-educational schools in the local government area based on the existence in those schools of well-equipped physics laboratories and experienced physics teachers with teaching qualification. Simple random sampling technique (precisely balloting) was used to assign experimental and control treatments to the schools.

The technique was used so as to provide classes where boys and girls work together under the same classroom environment. Intact classes were used in the sampled schools so as not to disrupt the normal school activities. Four weeks were used for the experiment. Each week had two periods (double periods each) of 40 minutes per period. The control group was taught using lecture method which involves content-rich activities such as demonstrations, display of materials, explanation, assignments, experiments and quantitative problem-solving in motion: kinematics and dynamics; which does not involve the students in contextual instructional models' processes. For the experimental class, the same set of activities for the control group was carried out for both double periods; but in addition to discussing and writing down their observations, students were engaged in such real object like use of toy cars, trolley and students made toy vans to demonstrate motion in the laboratory.

In the course of the experiments, students were made to measure distance covered by the toys from point A to point B using metre rule and measuring tapes provided. With their stopwatch, they were able to estimate time taken to reach certain location. The researchers also designed a model that

enabled one student to walk from point A to point B, another to run from the same point A to point B. this enabled them to measure distance, time, speed of each of the student. Their velocity was also measured when direction of their motion was attached. Collision, momentum and impulse were also demonstrated using the toy cars which could connect to real-life road accidents. The instrument used for data collection were the Motion Achievement Test (MAT) adapted from WAEC past Questions between 2021-2025 consisted of 20 multiple-choice items with four options (prep-50). The instruments were face and content validated by three experts and the internal consistency reliability was done using Kuder Richardson 20 (KR-20) which yielded a coefficient of 0.81, indicating the instrument was fit and reliable for data collection. The instrument was administered to the students before and after the treatment. The test was scored by the researcher to avoid bias. The results obtained were used for analysis. Research questions were answered using mean and standard deviation (SD) while the hypotheses were tested using analysis of covariance (ANCOVA) with statistical package for social science (SPSS) version 23.

Results

The Levene’s test, linearity and normality check were carried out and the assumptions were met.

Research Question One: What is the mean achievement and standard deviation scores of students taught motion using CIM and those taught using TLM?

Table 1: Mean achievement and Standard deviation of scores of physics students taught motion using CIM and those taught TLM

Teaching Strategy	Pretest			Posttest			Mean Gain
	N	Mean	SD	N	Mean	SD	
CIM	45	30.09	10.79	45	58.27	9.44	28.18
TLM	60	29.87	12.29	60	51.68	11.72	21.81

Table 1 shows that the students taught motion using the CIM outperformed those taught via the TLM. While both groups started with similar pre-test scores, the CIM group achieved a significantly higher mean gain as 28.18 compared to the TLM group as 21.81. Again, both groups showed a reduction in standard deviation during the post-test, indicating that scores became more consistent and clustered closer to the mean after treatment.

Research Question Two: What is the mean achievement and standard deviation scores of male and female students taught motion using CIM and those taught using TLM?

Table 2: Mean achievement and Standard deviation scores of male and female physics students taught motion using CIM and their counterpart taught with TLM

Teaching Strategy	Gender	Pre-test			Post- test			Mean Gain
		N	Mean	SD	N	Mean	SD	
CIM	Male	25	31.60	12.73	25	59.12	8.58	27.52
	Female	20	28.20	7.62	20	57.20	10.55	29.00
TLM	Male	35	29.49	11.96	35	52.43	8.91	22.94
	Female	25	30.40	12.96	25	50.64	14.95	20.24

Table 2 shows that, female students on CIM achieved a higher mean gain of 29.00 than males with 27.52, resulting in a 1.48 difference favoring females. Conversely, in the TLM group, males achieved a higher mean gain of 22.94 compared to females with 20.24, showing a 2.70 difference favoring males. This suggests that while CIM benefited both genders, it was particularly effective for female students.

Research Question Three: What is the Interaction effect of teaching approaches and gender on students' achievement in motion?

Table 3: Summary of interaction effect between gender and teaching strategies on students' achievement scores in motion

Strategy	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Contextual	Male	58.77a	2.13	54.54	63.01
	Female	57.57a	2.39	52.84	62.30
Lecture	Male	52.53a	1.80	48.96	56.10
	Female	50.55a	2.13	46.32	54.77

a. Covariates appearing in the model are evaluated at the following values:
 Pretest = 29.9619.

Table 3 shows the interaction effect of CIM and gender on the mean achievement scores of SS 2 physics students taught motion. Male students taught with CIM had mean interaction of 58.77a while their female counterpart had mean interaction of 57.57a. Those taught with lecture method had mean interaction of 52.53a for male and 50.55a for female.

Research Question Four: What is the mean knowledge retention and standard deviation scores of students taught motion using CIM and those taught using TLM?

Table 4: Mean knowledge retention and Standard deviation of scores of physics students taught motion using CIM and those taught TLM

Teaching Strategy	Posttest			Retention			Mean Gain
	N	Mean	SD	N	Mean	SD	
CIM	45	58.27	9.44	45	53.67	9.16	-4.60
TLM	60	51.68	11.72	60	41.93	15.54	-9.75

Table 4 shows that the students taught motion using the CIM retained knowledge than those taught via the TLM. The CIM group retained a significantly higher mean gain as -4.60 compared to the TLM group as -9.75. The standard deviation scores of CIM reduced from 9.44 to 9.16 in post-test and retention respectively. This suggested that the students showed equal retention. The standard deviation scores of TLM increased from 11.72 to 15.54 in post-test and retention respectively. This suggested that the retention levels were spread apart from the mean scores. The treatment unequally enhanced retention among the students.

Research Question Five: What is the mean knowledge retention and standard deviation scores of male and female students taught motion using CIM and those taught using TLM?

Table 5: Mean knowledge retention and Standard deviation scores of male and female physics students taught motion using CIM and their counterpart taught with TLM

Teaching Strategy	Gender	Posttest			Retention			Mean Gain
		N	Mean	SD	N	Mean	SD	
CIM	Male	25	59.12	8.58	25	54.12	8.58	-5.00
	Female	20	57.20	10.55	20	53.10	10.03	-4.10
TLM	Male	35	52.43	8.91	35	39.29	15.62	-13.14
	Female	25	50.64	14.95	25	45.64	14.95	-5.00

Table 5 shows that students taught motion with the CIM model retained knowledge better than those in the TLM group. CIM Group: Both genders showed minimal "mean loss" (the drop between post-test and retention scores). Females lost slightly less (4.10) than males (5.00), a difference of 0.90. TLM Group: The knowledge loss was significantly higher, particularly for males who lost 13.14 points compared to the female loss of 5.00, showing an 8.14 difference in favor of females.

Research Question Six: What is the Interaction effect of teaching approaches and gender on students' knowledge retention in motion?

Table 6: Summary of interaction effect between gender and teaching strategies on students' knowledge retention scores in motion

Strategy	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Contextual	Male	54.12a	2.62	48.92	59.32
	Female	53.10a	2.93	47.29	58.91
Lecture	Male	39.29a	2.22	34.89	43.68
	Female	45.64a	2.62	40.44	50.84

Table 6 shows the interaction effect of CIM and gender on the mean retention scores of SS 2 physics students taught motion. Male students taught with CIM had mean interaction of 54.12a while their female counterpart had mean interaction of 53.10a. Those taught with lecture method had mean interaction of 39.29a for male and 45.64a for female.

Hypotheses

The following null hypotheses were tested at .05 level of significance:

H01: There is no significant difference in the mean achievement scores of students taught motion using CIM and those taught using TLM.

Table 7: Summary of Analysis of Covariance of effect of CIM on students' mean achievement scores in motion concept of physics by Treatment and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1825.094a	4	456.274	4.030	.005	.139
Intercept	31643.618	1	31643.618	279.459	.000	.736
Pretest	623.018	1	623.018	5.502	.021	.052
Strategy	1110.422	1	1110.422	9.807	.002***	.089
Gender	63.679	1	63.679	.562	.455	.006
Strategy * Gender	3.827	1	3.827	.034	.855	.000
Error	11323.154	100	113.232			
Total	325079.000	105				
Corrected Total	13148.248	104				

a. R Squared = .139 (Adjusted R Squared = .104)

Table 7 shows that at .05 level of significance, there was a significant main effect of the CIM on students' mean achievement scores in physics concept of motion, $F(1, 100) = 9.807, P(.002) < .05$. Therefore, the null hypothesis was rejected. Thus, there is significant difference in mean achievement scores of SS 2 physics students taught motion using CIM and those taught using lecture method. The result showed favoritism of the experimental group. Partial eta squared showed significant contribution of 8.9% mean achievement scores resulting from CIM.

HO2: There is no significant difference in the mean achievement scores of male and female students taught motion using CIM and those taught using TLM.

Table 7 shows that at .05 level of significance, there was no significant influence of gender on the effect of teaching strategy on students' mean achievement scores in motion concept of physics, $F(1,100) = .562$, $P(.455) > .05$. Therefore, the null hypothesis was not rejected. Thus, gender has no significant influence on the mean achievement scores of students in motion concept of physics using CIM. Partial eta squared showed insignificant contribution of 0.6% on mean achievement resulting from CIM.

HO3: There is no significant interaction effect of gender and teaching methods on students mean achievement scores in physics.

Table 7 further revealed that at .05 level of significance, there was no significant interaction effect of gender and the CIM on students' mean achievement in motion, $F(1, 100) = .034$, $P(.855) > .05$. Therefore, the null hypothesis was not rejected. Thus, there is no significant interaction effect of gender and the CIM on students' mean achievement in motion concept of physics. Partial eta squared showed insignificant contribution of 0.0% mean achievement resulting from CIM.

HO4: There is no significant difference in the mean knowledge retention scores of students taught motion using CIM and those taught using TLM.

Table 8: Summary of Analysis of Covariance of effect of CIM on students' mean knowledge retention scores in motion concept of physics by Treatment and Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4140.505a	3	1380.168	8.040	.000	.193
Intercept	232828.674	1	232828.674	1356.361	.000	.931
Strategy	3134.456	1	3134.456	18.260	.000***	.153
Gender	179.443	1	179.443	1.045	.309	.010
Strategy * Gender	342.938	1	342.938	1.998	.161	.019
Error	17337.343	101	171.657			
Total	253047.000	105				
Corrected Total	21477.848	104				

a. R Squared = .193 (Adjusted R Squared = .169)

Table 8 shows that at .05 level of significance, there was a significant main effect of the CIM on students' mean retention scores in physics concept of motion, $F(1, 101) = 18.260$, $P(.000) < .05$. Therefore, the null hypothesis was rejected. Thus, there is significant difference in mean retention scores of SS 2 physics students taught motion using CIM and those taught using lecture method. The result showed favoritism of the experimental group. Partial eta squared showed significant contribution of 15.3% mean retention scores resulting from CIM.

HO5: There is no significant difference in the mean knowledge retention scores of male and female students taught motion using CIM and those taught using TLM.

Table 8 shows that at .05 level of significance, there was no significant influence of gender on the effect of teaching strategy on students' mean retention scores in motion concept of physics, $F(1,101) = 1.045$, $P(.309) > .05$. Therefore, the null hypothesis was not rejected. Thus, gender has no significant influence on the mean retention scores of students taught motion concept of physics using CIM. Partial eta squared showed insignificant contribution of 1.0% on mean retention resulting from CIM.

HO6: There is no significant interaction effect of gender and teaching methods on students mean knowledge retention scores in physics.

Table 8 further revealed that at .05 level of significance, there was no significant interaction effect of gender and the CIM on students' mean retention in motion, $F(1, 101) = 1.998, P(.161) > .05$. Therefore, the null hypothesis was not rejected. Thus, there is no significant interaction effect of gender and the CIM on students' mean retention taught motion concept of physics. Partial eta squared showed insignificant contribution of 1.9% mean retention resulting from CIM.

Discussion

The findings from research question 1 and 4 revealed that students taught motion using CIM and those taught with TLM were similar in terms of their achievement scores in the pretest. However, after the experiment, the experimental group (CIM) performed better in achievement score and knowledge retention than those taught using TLM. From hypotheses 1 and 4, a significant difference existed between the academic achievement scores and knowledge retention of the experimental and control groups in favor of the experimental group. This result is consistent with the findings of Setiawati (2018), Sarwinda (2020), Setiawati, Ramadhan and Gani (2018). CIM has the potential to make students to achieve better and retain knowledge in physics. Findings suggested that contextual instruction models foster enhanced achievement by allowing learners to see the relevance of physics in real-world contexts, thus promoting active learning and critical thinking.

The findings from research question 2, 5 and hypotheses 2, 5 showed that gender has no significant influence on students' achievement and knowledge retention on Physics concepts of motion using CIM. This is because, significant difference did not exist between the achievement and knowledge retention scores of male and female students in the experimental group (CIM). The result agrees with Akten and Acar (2019), Lotulung, Ibrahim and Tumurang (2018). The use of CIM showed equity among Physics students irrespective of gender.

Furthermore, the findings of research question 3, 6 and hypotheses 3, 6 showed no significant interaction effect between CIM and gender on students' academic achievement and knowledge retention scores in Physics concept of motion. This result agreed with the findings of Taber (2013), who discovered no significant interaction between gender and CIM on students' conceptual change in physics.

Conclusion

Incorporating contextual instructional models in physics teaching, especially in topics like motion, showed significant improvement in student achievement and knowledge retention. CIM showed no gender bias together with the interaction of the models.

Recommendations

Based on the findings of the study, it is recommended that Educators should be encouraged to integrate real-world problems and scenarios into their pedagogical approaches to make physics more accessible and engaging. Teacher-training programme designers should incorporate CIM in their curriculum, while practicing teachers should be re-trained in the CIM through seminars, workshops, conferences, in-service trainings, annual teacher vacation courses, and refresher courses.

References

- Achufusi-Aka, N. N and Okpanachi, E. E. (2021). Effect of collaborative learning strategy on students' academic achievement in chemistry in Onitsha education zone, Anambra state. *International scholars of arts and social sciences*, 4, (1)190-199
- Akten, B., and Acar, S. (2019). Effects of Contextual Learning on Students' Achievement in Physics. *Journal of Physics Education*, 20(3), 45-58.
- Cakmak, M., and Karamustafa, K. (2014). Students' understanding of motion concepts and the effectiveness of contextual approaches. *International Journal of Science and Mathematics Education*, 12(4), 789-809.
- Chen, S.-Y., and Tsai, C.-C. (2012). Constructivist learning environments in physics education. *Science Education Review*, 11(2), 89-102.
- Ezeano, C. A. (2018). *Science teaching for Effective Development in Nigeria schools*, Enugu, Ecnel printing
- Fisher, J. S. and Radvansky, G. A. (2018). Patterns of forgetting. *Journal of memory and language*.102, 130-141. <https://doi.org/10.1016/j.jml.2018.05>
- Hestenes, D. (1992). The momentum of teaching physics: A constructivist, active learning paradigm. *Physics Teacher*, 30(3), 159-162.
- Ibe, E. and Abonyi A.A. (2015). Effects of Guided Inquiry and Demonstration on Science Process Skills Acquisition among Secondary School Biology Students. *Journal of the Science Teachers' Association of Nigeria*, 43(5)58-56.
- Liu, J., and Lee, H. (2020). The role of context-based teaching in physics achievement. *Journal of Science Education*, 34(2), 112-127.
- Lotulung, C. F., Ibrahim, N., and Tumurang, H. (2018). Effectiveness of Learning Method Contextual Teaching Learning (CTL) for Increasing Learning Outcomes of Entrepreneurship Education. *Turkish Online Journal of Educational Technology TOJET*, 17(3), 37-46.
- Nwankwo, M. C. and Okoye, K. R. E. (2015). Influence of college clubs in increasing students' interest and achievement in Nigerian post – primary schools as perceived by science students. *Journal of Education and Practice*, 6(18), 184 – 193. www.iiste.org.
- Nworgu, B.G. (2016). *Educational Research Methods: Basic Issues and methodology* (4th ed). By University Trust Publisher Nsukka, Enugu
- Onah, K. T. (2022). Effect of scaffolding Teaching Approach on students' academic achievement in Quantum Physics in Enugu Education Zone. *Greener Journal of Educational Research*, 12 (1)13-21.
- Onah, K. T. and Achufusi, N. N. (2022). Effect of Meta-conceptual teaching approach on students' academic achievement and interest in Quantum physics in Enugu Education Zone. *African Journal of Science Technology and Mathematics Education*. 8(1) 80-90.
- Onah, K. T., Anamezie, R. C. and Nnadi, F. O. (2022). Effect of mind-mapping teaching approach on students' academic achievement in physics concepts of motion and kinematics. *Greener Journal of Educational Research*.12 (1)31-40.
- Piaget, J. (1952). *The origins of intelligence in children*. International Universities Press.
- Taber, K. S. (2013). *Constructivist approaches in physics education*. *Physics Education*, 48(2), 117-123.
- Sarwinda, K. R. (2020). The development of audio-visual media with a contextual teaching-learning approach improves learning motivation and critical thinking skills. *Psychology, Evaluation, and Technology in Educational Research*, 2(5), 98–114.

- Setiawati, N. K., Ramadhan, S., and Gani, E. (2018). *The effect of contextual teaching and learning model and motivation towards skill of fable text writing*. In International Conference on Language, Literature, and Education.
- West African Examination Council (WAEC). (2017-2025). *Chief Examiners Report on Students performance in senior Certificate Chemistry Examination Lagos*: West African Examination Council
- World Health Organization (2020). Webinar: Policies to develop, attract, recruit and retain health workers in rural and remote areas, and promote gender equality for rural women through health workforce polices.