Innovations

Effect of Gagne's Learning Hierarchy on Students' Achievement, Retention and Attitude in Secondary School Physics in Delta State, Nigeria

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Abstract

This study examined the effects of Gagne's learning hierarchy on students' achievement, retention and attitude in Secondary School Physics in Delta State. The theoretical framework in which the study was anchored on is Ausubel's Cognitive Theory (1963). The study employed a 2x3 factorial non-equivalent pre-test post-test control group design. Three (3) research questions and three (3) null hypotheses were tested at 0.05 level of significance. A sample size of two hundred and eleven (211) SS II Physics Students from six (6) public secondary schools in Delta State were involved. These were taught physics utilizing Gagne's Learning Hierarchy in the experimental groups made up of one hundred and sixteen (116) students and lecture method the control group utilized ninety-five (95) students. The instrument used were Physics Achievement Test (PAT) and Physics Students Attitude Scale. The instrument were validated by experts in science education. Reliability indices of 0.79 for PAT and 0.73 for Attitude Scale. The data collected were analyzed using Mean, Standard Deviation and Independent t-test. The findings showed that Gagne's Learning Hierarchy has positive effects on physics students' achievement, retention and attitude. It was recommended among other things, that physics teachers should adopt the use of Gagne's Learning Hierarchy in teaching secondary school physics. Government agencies responsible for teacher development programmes should train physics teachers on the use of Gagne's Learning Hierarchy to enable the physics teachers construct effective lesson plans on this innovative and collaborative instructional strategy.

Keywords: *1.Gagne's Learning Hierarchy, 2.Strategy, 3.Achievement, 4.Retention And Attitude.*

Introduction

Basically, Physics is a science subject that deals with the properties of matter and its interaction with energy. It is typically an experimental subject. Values and thoughts bring forth from physics are very helpful in understanding of natural events. The concentration of physics instructions is to usher students to the knowing of physics values and to have the cognition to utilize this knowledge. It is a field specifically obsessed with two basic aims, the presentation of a scientifically sophisticated society and the improvement of latent scientific and technological workforce (Akpokiniovo, 2022).

Consequently, the National Policy on Education (FRN, 2004, 2007, 2013) expressed explicitly in the secondary school physics curriculum its objectives as:

i. provide basic literacy of physics for functional living in the society,

ii. acquire basic conceptions and values of physics as a provision for promoting studies,

iii. get indispensable technological ability and cognition as a provision for the technical utilization of Physics, and

iv. excite and heighten creativeness

Physics as a fundamental science deals with the matter and energy in nature. Many students perceive physics to be difficult despite different interventions, such as the introduction of new Educational Systems. Literature abound (Barmby and Defty, 2006; Lavonen, Meisano, Byman, Uiito and Juiit, 2005; Angell, Guttersrud, Henriksen and Isnes, 2004; Williams, Stanisstreet, Spall, Boyes and Dickson, 2003) that students specifically distinguish against physics as conceptually challenging, intangible, and boring that only extraordinary exceptional students' acknowledge and endure its instruction and learning. Nevertheless, educators steadfastly accept that students acquire high-grade and accomplish in physics if they discover the instruction understandable (Gebbels, Evans and Murphy, 2010). Additionally, these writers asserted that students' conceptualization of physics determines their knowing and acquisition of the course of study.

Despite the importance of this subject, it is widely recognized that the teaching and learning of Physics has been taught with challenges such as low enrollment both in secondary schools and in tertiary institutions in Nigeria. Noteworthy of the justification for reduced enrollment of learners studying Physics in institution of learning are: miserable Scientific discipline and Mathematics heritage of learners at the junior secondary level of education, ill equipped Physics laboratory, incompetent condition of instructors, pathetic wages, deficient figure of well-qualified Physics instructors and unsuitable instructional approaches engaged by the science instructors (Jegede and Adedayo, 2013).These factors have equally added to the decline in attitude, achievement and retention in physics by students who enrolled for the subject at Senior School Certificate Examinations (SSCE). This is evident in the West African Examination Council (WAEC) results between 2010 and 2018 as presented table 1 below.

Table 1: Trends in Students' Achievement in Physics in the May/June West African Senior School Certificate Examination (WASSCE) (2010-2018)

Year	Subject	Total no. of Candidates	No. of Credit Pass	% Pass	No. of Fail	% Fail
2010	Physics	487, 963	159, 264	32.64	324, 699	67.36
2011	Physics	587, 772	157, 543	26.80	430, 229	73.20
2012	Physics	324, 998	126, 131	38.81	198, 866	61.19
2013	Physics	298. 971	86, 612	29.17	212, 359	70.83

2014	Physics	241, 161	72, 522	29.27	168, 639	70.73
2015	Physics	529, 425	165, 604	31.28	363, 820	68.72
2016	Physics	488, 113	161, 522	33.09	362, 591	66.90
2017	Physics	391, 745	121, 988	31.14	269, 757	68.86
2018	Physics	359, 818	101, 774	28.28	258, 044	71.72

Source: West African Examination Council, Research, and Statistics Unit, 2018

This implied that only a few students would eventually be able to pursue Physics related careers in higher institutions. This will consequently have great implication on manpower development in Engineering and other related professional fields. The observed declination of achievement with respect to secondary school physics students' is of serious concern among researchers, scholarly persons and assessment organizations. It is worthy to note that several affiliated surveys were investigated by various researchers of science education in Nigerian and other nations (Akpokiniovo, 2022; Bilesanmi-Awoderu, 2012; Abdulraheem, 2012; Ibidapo-Obe, 2007; Ajayi, 2007; Mankilik, 2006 and Ajayi, 2000) with respect to cognitive content which includes instructional approaches, learning environment interaction pattern, curriculum evaluation and implementation. In Nigeria, among the above factors, the issue of inappropriate method of presentation and conversation strategies applied by teachers in physics delivery is a concern. Bilesanmi-Awoderu (2012) asserted that poor instructional approach adopted by teachers is majorly responsible for poor achievement scores of the students in physics. To him most teachers are on the habit of using lecture method and sometimes rote learning where the student solely depend on memorization of concepts rather than complete understanding of the subject content and concepts.

Gagne's Learning Hierarchy gives teachers a procedure required to be utilized earlier to prosecute instruction. Every measure details a kind of information which supports the acquisition procedure. At the completion of a particular phase, the students' participation will be achieved and the retention of communicated details or abilities which they are being taught. These steps are (i) gaining attention (ii) informing learners of objectives (iii) stimulating recall of prior knowledge (iv) presenting the stimulus (v) providing learning guidance (vi) eliciting performance (vii) providing feedback (viii) assessing performance (ix) enhancing retention and transfer.

Gagne's learning hierarchy has the major advantage for students to problem-solving skills and enhances retention as well as application of physics concepts. Simha (2000) stated that studies carried out on the effects of Gagne's learning hierarchy compared to the traditional lecture method shows that there is superiority of Gagne's learning hierarchy over the traditional lecture method. This was evidently noticed in its positive impact in the areas of achievement, retention and attitude on application of principles and problem-solving skills in physics.

Sex is the state of being male or female. Therefore, the study also investigated whether the achievement, retention and attitude of physics students' that were exposed to the two instructional strategies under study depend on sex. Researchers discovered in respect of the boy learners accomplish importantly better than their female equivalent in physics (Aguele and Agwugah, 2008; Kolawole, 2007; Bamidele, Odusola and Dibu-Oyerinde, 2006; and Okebukola, 2002). Also, Amoo, 2011; Umar, 2008 and Christine, 2004 in their separate studies were of a different view that the performances of female students in science subjects studied were better than that of the male counterparts. In another conflicting view also, generally in Nigeria if not Africa as a whole, it is a belief that male students are at the forefront when compared to the female counterparts in physics (Adigun, Onihunwalrunokhai, Sada and Adesina, 2015). The achievement of male and female physics students' is contradictory. This implies that an important deviation among the achievement scores of boy versus girl physics students have not been conclusively reached by researchers. Therefore a research of this quality is necessitated.

This study was carried out to find solution to students' poor achievement, retention and attitude towards secondary school physics in public examinations with the use of interactive, collaborative and student-centred instructional strategies as recommended in the National Policy on Education (FRN, 2013). Interactive, collaborative and student- centred instructional strategies invariably have improved students' achievement, retention and attitude in physics. Gagne's learning hierarchy in no doubt has enhanced students' achievement, retention and attitude towards physics.

Physics students' achievement, retention and attitude as have been observed is certainly on the decline. Among other factors instructional strategy utilized with respect to Physics teaching in our secondary schools have been responsible for the physics students' poor achievement in external examinations. The lecture method used as medium of instruction in teaching physics in Delta State secondary schools have never encouraged students' effective participation in the learning process and this have resulted in poor achievement, retention and attitude in secondary school physics. In this study therefore, the researcher used innovative and collaborative instructional strategy such as Gagne's learning hierarchy to promote physics students effective participation in secondary school physics in Delta State.

Statement of the Problem

A review of West African Examinations Council (WAEC) Chief Examiners' report from 2010-2018 have shown that students' achievement in physics is on a continuous decline as shown in Table 1 above. Physics in students' abysmal poor academic achievement in physics West African Senior School Certificate Examination (WASSCE) has been attributed to poor teaching methods among others. The lecture method which is almost normally utilized in Nigerian senior secondary schools has made students resort to memorization of Physics content due to their passive roles during the teaching-learning process. The learners instructed in a lecture method classroom are not given the opportunity to be active participants through interaction, collaboration and pedagogy and acquisition activity. These calls for the adoption of alternative teaching strategies that involves students' active participation, interaction and collaboration which can motivate and encourage problem solving skills in the students. Gagne's Learning Hierarchy is among the alternative strategies, since it gives students the opportunity to participate, interact and collaborate among themselves in a knowledge acquisition activity, thereby improving their difficulty resolution abilities and enhancing their achievement. Hence the problem of this study is: Is there any effect of Gagne's Learning Hierarchy on students' Achievement, Retention and Attitude in Secondary School Physics?

Specific objectives of the study

Specifically, this research was designed to find out:

i. If there is any difference in the mean achievement scores among physics students that were exposed to Gagne's Learning Hierarchy and Lecture Method.

ii. If there is any difference in the mean retention scores of physics students that were exposed to Gagne's Learning Hierarchy and Lecture Method.

iii. If there is any difference in the mean attitude scores of physics students that were exposed to Gagne's Learning Hierarchy and Lecture Method.

Research Questions

The following research questions were raised to guide the study.

i. What is the difference in the mean achievement scores of physics students that were exposed to Gagne's Learning Hierarchy and Lecture Method?
ii. What is the difference in the mean retention scores of physics students that were exposed to Gagne' s Learning Hierarchy and Lecture Method?
iii. What is the difference in the mean attitude scores of physics students that were exposed to Gagne's Learning Hierarchy and Lecture Method?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

i. There is no significant difference in mean achievement scores of physics students exposed to Gagne's learning hierarchy and Lecture Method.
ii. There is no significant difference in mean retention scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method.
iii. There is no significant difference in mean attitude scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method

Methodology

The study design is a 2x3 non-equivalent pre-test post-test control group design. This is a quasi-experimental design. It examines the effect of Gagne's learning hierarchy on the dependent variables. The study involved experimental and control groups consisting of both male and female students. A pre-test was administered to the groups, before the treatment to determine the groups 'comparative effects of experimental and control groups on achievement, retention and attitude in secondary school physics. The experimental group was instructed on physics concepts utilizing Gagne's learning hierarchy. The control group was instructed on similar concepts utilizing lecture method. A posttest was administered to both groups after the treatment period of six (6) weeks to establish the effects of the treatments on the dependent variables.

Population for the Study

The population of the study involved all Public Senior Secondary School two (SS II) Physics students in Delta state. The three Senatorial Districts (Delta Central, Delta North and Delta South) respectively were considered as the entire state. The total population of SS II Physics students is fifteen thousand, six hundred and fifty nine (15,659)comprising of 7,811 and 7,848 male and female students respectively from a sample of four hundred and thirty five (435) Public Secondary Schools in Delta State.

Sample and Sampling Technique

The study employed simple random sampling technique and designated two hundred and eleven (211) SS II Physics Students from six (6) public secondary schools drawn from four hundred and thirty five (435) public secondary schools in Delta State. This sample utilized six (6) SS II physics whole classes of senior secondary II students from the six (6) chosen schools. Two mixed schools of each senatorial district made-up the sampled schools.

This study employed simple random sampling techniques at all stages of selection. At the first stage, a simple random sampling utilized in selecting one LGA of each senatorial districts. Secondly, simple random sampling utilized to select two (2) mixed secondary schools of each LGA's selected. Thirdly, the study applied simple random sampling technique and selected SS II class as the intact class among the selected schools. The designated schools were randomly assigned to experimental and control groups through" hat and draw" method. This method was randomly applied and eradicated any form of bias in the selection.

Instrumentation

The study used two (2) research instruments including Physics Achievement Test (PAT) and Physics Students Attitude Scale (PSAS). The Instruments were validated through face validity, content validity and construct validity. Reliability Indices of 0.79 for PAT and 0.73 for PSAS were obtained through Kuder-Richardson formula 21 and Cronbach-Alpha formula respectively.

Procedure for Data Collection

To ensure effective data collection the two groups, experimental and control groups were instructed individually for six weeks using the intervention packages. The instruments developed by the researcher were administered both at initial stage i.e pretest and after the completion of the treatment, a posttest was administered. Also a retention posttest was administered three (3) weeks after the administration of the posttest to test the physics students' retention level. The students' responded to the items in the presence of the research assistant. The items on both PAT and PSAQ research instruments were used to retrieve responses from the students' at every stage of administration. After the pretest the items were rearranged before the posttest and retention posttest were administered.

Data Analysis Technique

The data retrieved from the administered Physics Achievement Test (PAT) and Physics Students Attitude Questionnaire (PSAQ) were analyzed utilizing mean, standard deviation and independent t-test. The significant level for rejection or acceptance of the hypotheses were $p<0.05$

Analysis and Results

Hypothesis 1: There is no significant difference in mean achievement scores of physics students exposed to Gagne's learning hierarchy and Lecture Method. The result is presented in table 2 below

Table 2: Independent t-test analysis on difference in mean achievement scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method

Groups	N	Mean	SD	Mean Diff	Df	t.cal	Sig. (2 tailed)	Remark
GLHS	116	68.76	12.62	30.64	209	17.67	0.000	Significant
LM	95	38.12	12.43					

P<0.05

From Table 2, it is evident that a t-value of 17.67 and a P-value of 0.000 were achieved. Testing at an alpha level of 0.05, the P-value is less than the alpha level, therefore the null hypothesis which states that there is no significant difference in mean achievement scores of secondary school physics students exposed to Gagne' Learning Hierarchy and Lecture Method was rejected. This implied that there is a significant difference in mean achievement scores of secondary school physics students exposed to Gagne's Learning Hierarchy and Lecture Method in favour of Gagne's Learning Hierarchy Strategy (GLHS).

Hypothesis 2: There is no significant difference in mean retention scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method.

Table 3: Independent t-test analysis on difference in mean retention scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method

Groups	N	Mean	SD	Mean Diff	Df	t.cal	Sig. (2 tailed)	Remark
GLHS	116	98.90	11.49	31.58	209	23.53	0.000	Significant
LM	95	27.32	8.16					

P<0.05

Table 3 reveals a t value of 22.53 and a P-value of 0.000. Testing at an alpha level of 0.05 the P-value is less than the alpha level. Therefore, the null hypothesis which states that there is no significant difference in mean retention scores of physics students exposed to Gagne's learning hierarchy and Lecture Method is rejected. This indicates that there is a significant difference in mean retention scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method in favour of Gagne's Learning Hierarchy in the instruction of secondary school SS II physics.

Hypothesis 3: There is no significant difference in mean attitude scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method.

Table 4: Independent t-test analysis on difference in mean attitude scores of physics students exposed to Gagne's learning hierarchy and Lecture Method

Groups	N	Mean	SD	Mean Diff	Df	t.cal	Sig. (2 tailed)	Remark
GLHS	116	87.97	12.52	28.76	209	16.90	0.000	Significant
LM	95	59.21	12.01					

P<0.05

Table 4 shows a t-value of 16.90 and a P-value of 0.000. Testing at an alpha level of 0.05 the P-value is less than the alpha level. Therefore, the null hypothesis which states that there is no significant difference in

mean attitude scores of physics students exposed to Gagne's learning hierarchy and Lecture Method is rejected. This indicates that there is a significant difference in mean attitude scores of physics students exposed to Gagne's Learning Hierarchy and Lecture Method in favour of Gagne's learning hierarchy in the instruction of secondary school physics.

Discussion

The findings of this study with respect to the effectiveness of Gagne's learning hierarchy on students achievement in senior secondary school physics is in agreement with the work of Shachak, Ophir, Rubin and Fine (2005). Their study examined Gagne's learning hierarchy when likened to the customary acquisition technique on students' achievement in science. The study showed that Gagne's learning hierarchy with its instructional events is effective in bringing about improvement in classroom instruction. The finding reaffirmed that students exposed to Gagne's learning hierarchy achieved more with respect to concepts in science and physics inclusive when compared to students that were taught conventional teaching method.

From the findings, Gagne's Learning Hierarchy is more effective than the Lecture Method. One possible explanation for this is that Gagne's learning hierarchy possess the potentials of sustaining pupils induction and involvement while helping students' to develop difficulty resolution ability in physics. Gagne's learning hierarchy strategy provided students' the opportunity to participate effectively regarding instruction-acquisition situation and it has encouraged them in building self-confidence in solving physics problems. The lecture technique being an instructor dominated activity never encourages students effective engagement regarding teaching-learning process as a teacher-centred technique. The present finding supports Kim (2016) who stated that Gagne's learning hierarchy was more effective regarding improving learners' content knowledge in science and retention than the lecture method. The finding also supports an investigation regarding Savinainen, Makynen, Nieminen and Viiri (2017), who revealed that Gagne's Learning was superior to lecture teaching method on learners understanding and retention regarding Newton's third Law of motion in physics.

The findings disclosed a situation whereby a significant difference existed among the mean attitude scores of physics students that were tutored through Gagne's Learning Hierarchy and Lecture Method. One possible explanation for this discovery should be Gagne's learning hierarchy strategy possession of the potentials to arouse and sustain pupils' induction and involvement while helping students' to develop difficulty resolution ability in physics. Gagne's learning hierarchy provided students' the opportunity to participate effectively in instruction-acquisition situation and it has encouraged them in building self-confidence in solving physics problems. The lecture technique being an instructor dominated activity never encourage students' effective engagement regarding teaching-learning process being a teacher-centred approach. The findings also support the studies of Moore and Stanley (2010), who revealed that Gagne's Learning Hierarchy strategy was superior to lecture teaching method on learners understanding and attitude of Newton's. third Law of motion in physics.

Conclusions

From these findings and discussions, conclusions can be drawn that Gagne's learning hierarchy has helped in improving the academic achievement, retention and attitude of senior secondary school physics students. Therefore Gagne's learning hierarchy is viable and has the potential of enhancing senior secondary school physics students' academic achievement, retention and attitude in physics concepts and contents.

Recommendations

In accordance with the findings, the following recommendations are made:

i. In term of academic achievement, retention and attitude in senior secondary school physics, this study shows that Gagne's learning hierarchy enhanced the academic achievement, retention and attitude in physics as compared to lecture method. The utilization of Gagne's learning hierarchy by physics teachers should therefore be encouraged in Nigerian senior secondary schools.

ii. Government agencies responsible for teacher development programmes should train physics teachers on the use of Gagne's Learning Hierarchy to enable the physics teachers construct effective lesson plans on this innovative and collaborative instructional strategy. This has been one of the major obstacles militating against teachers' adoption of this technique in senior secondary school physics classroom teaching.

References

1. *Abdulraheem, R.F. (2012). Conception of electromagnetism held by colleges of education physics students in North Central States, Nigeria. [Unpublished Ph D Thesis], University of Ilorin, Ilorin.*
2. *Adigun, I., Onihunwa, J., Irunokhai, E., SaSa, Y., & Adesina, O. (2015).Effect of gender on students' academic performance in Computer Science in secondary schools in New Bussa, Borgu Local Government of Niger State. Journal of Education and Practice, 6(33), 1-7.*
3. *Aguele, I. I &Agwugah, N.M (2007). Female participation in Science, technology and Mathematics (STM) Education in Nigeria and national development. Social Science, 15(2), 121-126.*
4. *Ajayi, P. O. (2000). Effectiveness of practical and theoretical methods on students' performance in Physics in selected secondary schools in Akure South Local Government Area of Ondo State. [An unpublished M.Ed. thesis], University of Ado-Ekiti, Nigeria.*
5. *Ajayi, R. O. (2007). Evaluation of the implementation of senior secondary school Physics curriculum in south west Nigeria [unpublished Ph.D. thesis], University of Ado-Ekiti, Nigeria*
6. *Akpokiniovo, S.R. (2022). Effects of self-instruction and guided inquiry teaching strategies on secondary school physics students' achievement'Rivers State University Journal of Education. 25(1), 156-165*
7. *Amoo, E. D. (2011). Gender and academic performance in Nigerian universities: Economic implications. International Journal and Research in Education, 8(1), 159-172*
8. *Angell, C., Guttersrud, O., Henriksen, E. K. &Isnes, A. (2004). Physics: Frightful, but fun. Pupils' and teachers' views of physics and physics teaching. Science Education, 88(5), 683-706.*
9. *Bamidele, A.R, Odusola, O. &Ojerinde, D. (2006). Review of the environment and performance of male and female students in Education Economics programme of Obafemi Awolowo University, Ile-Ife. Nigerian Journal of Social Science, 12(2), 143- 146.*
10. *Barmby, P. &Defty, N. (2006). 'Secondary school pupils' perceptions of physics.' Research in Science Technological Education., 24 (2), 199-2 15.*
11. *Bilesanmi-Awoderu, J. B. (2012).Science education in Nigeria drowning but waving. An inaugural lecture. Tunfas printing press. Pp 46-48.*
12. *Christine, P. (2004). Gender proves large factor in academic performance: The pendulum [Online]. March 11, edition Eridemir, N. &Bakirci, H. (2009). "The Change and the Development of Attitudes of Science Teacher Candidates towards branches". Kastamonu Education Journal, 17(1), 161-170.*
13. *Federal Republic of Nigeria (2004) National Policy on Education (Revised) Yaba Lagos, NERDC.*
14. *Federal Republic of Nigeria (2007). National Policy on Education (Revised) Yaba Lagos, NERDC.*

15. *Federal Republic of Nigeria (2013). National Policy on Education (Revised) Yaba Lagos, NERDC.*
16. *Gagne, R. M. (1965). The conditions of learning. New York: Holt, Rinehart & Winston.*
17. *Gebbels, S., Evans, S. M. & Murphy, L. A. (2010). Making science special for pupils with learning difficulties. British Journal of Special Education, 37(3), pp. 139-147.*
18. *Ibidapo-Obe, O. (2007). The Challenge of Teacher Education in Nigeria: The University of Lagos Experience, Paper presented at the second Regional Research Seminar for Africa Organized by UNESCO forum on Higher Education, Research and Knowledge, Accra, 22-24, March. 1- 11.*
19. *Jegede, S. A. & Adebayo, J. O. (2013). Enriching physics education in Nigeria towards enhancing sustainable development. Greener Journal of Educational Research, 3(2), 71-74.*
20. *Kim, H. (2016). Inquiry-based science and technology enrichment program for middle school-aged female students. Journal of Science Education and Technology, 25(2), 174-186.*
21. *Kolawole, E. B. (2007). Sex differences in academic achievement in science subjects in Nigeria tertiary institution. Research in Curriculum Studies, 2,168-173.*
22. *Lavonen, J. Meisano, V. Byman, R, Uiito, A. &Juiit, K. (2005). Pupils' interest in physics: A survey in Finland NORDINA , 2 (2005), 72-85*
23. *Mankalik, M. (2006). Effects of demonstration and guided discovery Methods in correcting misconceptions in physics among remedial students, University of Jos, [Unpublished Ph.D. Thesis], University of Ilorin, Ilorin.*
24. *Moore, B., & Stanley, T. (2010).Critical thinking and formative assessments. Increasing the Rigour in Your Classroom. Routledge*
25. *Ogunniyi M. B. (2001). Effects of Science and Technology on Traditional Beliefs and Cultures. SSME, University of Western Cape.*
26. *Okebukola, O.O. (2002). Beyond the stereotype to new trajectories in Science teaching. Ibadan:Science Teachers Association of Nigeria.*
27. *Savinainen, A., Makynen, A., Nieminen, P., &Viiri, J. (2017). The effect of using a visual representation tool in a teaching-learning sequence for teaching Newton's third law. Research in Science Education, 1(47), 119-135.*
28. *Shachak, A., Ophir, R., Rubin, E., & Fine, S. F. (2005). Instructional design theories in bioinformatics education: Ai application of Gagne's "Conditions of Learning" to microarray analysis training. Presentation at the Workshop on Education in Bioinformatics (WEB). Brisbane. Australia.*
29. *Simha, S. K. S. (2000). Development of an instructional model in physics based on Robert Gagne's theory of learning for the promotion of problem-solving skills among students of secondary schools [Ph.D. Thesis], Bangalore University*
30. *Umar, A.Y. (2008). Comparative study of the enrollment and academic performance in Physics of male and female students in some selected secondary schools in Katsina State. Nigerian Journal of Science and Educational Research. 40(1), 131-139.*
31. *West African Examination Council (WAEC 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017 and 2008). Chief Examiner's Report, Senior Certificate Examination. May/June 2019. 91-109.*
32. *Williams, C., Stanisstreet, M., Spall, K., Boyes, B., & Dickson, D. (2003). Why aren't secondary students interested in physics? Physics Education, 38(4), 324-329.*