Journal of Capital Development in Behavioural Sciences Vol. 4. Issue 1 (June, 2016)
Faculty of Arts & Education, Lead City University, Ibadan, Nigeria
***ISSN: Online** 2449-0679; **Print** 2354-3981*

Effect of Discussion and Invention Teaching Strategies on Senior Secondary School Students Achievement in Chemistry in Delta State, Nigeria

Ejedafeta A. Okurumeh, Ph.D
Department of Mathematics, School of Science,
College of Education. Warri, Delta State

Abstract

This study investigated the effect of Discussion and Invention Strategies on achievement in chemistry. The moderating effects of academic ability and gender were also investigated. The study adopted a pretest, posttest, follow up test, and control group quasi-experimental design with a 3x2x2 factorial matrix. The participants consisted of 224 senior secondary II chemistry students from intact classes in nine selected secondary schools in delta central senatorial district. The instrument for data collection include "Chemistry achievement test", (r = 0.84), "Ability test in Chemistry", (r = 0.85) and teachers instructional package. Six research questions were asked and answered, while three hypotheses were formulated and tested at 0.05 alpha levels. Data were analysed using analysis of variance and covariance, while Sheffe Post-hoc analysis was used to explain the significant difference. There were significant effects of treatment on students achievement in chemistry ($F_{(2.820)} = 73.77$) and students of varying abilities ($F_{(11.242)} = 2.03$). But, there were no significant effect of treatment on Gender on achievement ($F_{(1.000)} = 0.93$) in Chemistry. The two instructional strategies improved students' achievement in chemistry concepts more than the traditional lecture method. It was recommended that teachers should therefore adopt these two instructional strategies in the teaching of chemistry at the senior secondary school level.

***Keywords**: Achievement, Discussion and Invention*

Introduction

The importance and contributions of chemistry to the generality of mankind is a reason for its vital position as a core subject at the senior secondary level of education in Nigeria. On emphasis placed on the value of chemistry; the Joint Matriculation Board brochure (2015), stated that a minimum of credit pass in chemistry is required as one of the criteria for admitting candidates aspiring to do any science related course in the tertiary institutions. Examples include courses like; medical and health sciences, Physical science; engineering and a host of others. In spite of the recognition given to chemistry and its teaching; there has often been a gap between curriculum planners' intention and classroom practices (Kempa and Aminah; 1991). Effective teaching and learning of chemistry is dependent on the instructional strategy used. This is a major factor responsible for the poor level of achievement of students and their retention of chemistry concepts as reported by The West African Examinations Council (WAEC, 2012). Evidence from past research studies have shown that practicing chemistry teachers have relied so much on the traditional lecture teaching method of "talk and write" whereby the teacher works some examples on the board and students copy the examples into the exercise books and later gives problems to solve based on the examples worked upon. This approach does not allow for students active participation in the learning process and has led to researches on alternative teaching strategies which are more innovative, promoting better learning of chemistry (Igwe, 2001; Adeoye.; 2000 Alebiosu (1998), and Ojo 1989). The use of the traditional lecture method is often associated with poor achievement in chemistry and poor enrolment in the subject as widely reported in past studies within and outside Nigeria (Orji, 1998, Khan and Saeed; 2010).

The traditional lecture method involves the passing on of a body of facts consisting of concepts through the teacher's one-way interaction of talking and giving notes

However, the traditional lecture instructional strategy has been criticised for been teacher-centered and not being capable of sustaining the interest of students throughout the instructional period/process (Oludipe and Awokoya, 2010).

Studies done on instructional models where students participated in the process of investigation and discussion with one another, with the teacher, and learning materials; have shown to have improved students fundamental understanding in science (Growns and Cebulla 2000). Therefore, there is a need for an alternative strategy that would be able to sustain the interest of students and would involve a two-way student-teacher; and student-student interactions.

Discussion and invention teaching strategies are cognitive techniques based on the constructivist approach to science teaching. This approach is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction and invention of ideas as opposed to passively receiving information as in the traditional lecture method. The cognitive techniques and strategies are therefore student centred and the teacher's role is to facilitate experience that allows them to hypothesize, predict, manipulate objects, ask questions, research, investigate, imagine and invent. Constructivist theories have received considerable acceptance in science education in recent years. Wilson, Fernandez and Hadaway (2006) In the constructivist approach; the learner must be actively involved in the construction of his own knowledge rather than passively receiving knowledge. The teacher's responsibility is to arrange situations and contexts within which the learner constructs knowledge.

Constructivist learning strategies includes more reflective oriented learning activities such as exploratory learning. More specifically, these strategies include: problem solving, group learning, invention, discussion and situation learning (Murphy; 1997; Wood; Cobb and Yackel, 1991). Using discussion as teaching strategy which, according to Geoffrey, (2001), carries a hidden message- the teacher is in effect saying to his or her student "I value your experience and I am interested in your opinion". This is in contrast to the unspoken word of students in a lecture in "talk and write" teaching strategy which is that the students know nothing of value about the topic. Discussion teaching strategy is exploratory and involves a free-flow conversation giving students an opportunity to express their opinions and ideas and to hear those of their peers. It also helps to develop student's opinion; attitudes and values. Discussion could involve whole class or group working collaboratively together. The benefits of discussion are:

- The promotion of learning of academic skills
- The enhancement of group relations
- The promotion of metacognition in which students achieve higher levels of thinking at quicker rate than if they worked independently.
- The improvement of academic achievement through greater concentration as they remember what have been discovered and said by themselves as well as what others have said.

Proficiency in problem solving requires practice and when learner is given opportunities for practice; this leads to development of self-ability and competence of which the ultimate is invention, Zemelman, and Hyde (1993), assert that learning in all subject areas involves inventing and constructing new ideas. Invention strategy can therefore be used in the teaching and learning of chemistry. In the invention strategy; the students and teacher's roles may vary depending upon the nature of the content. Generally; students should be asked to "invent" part or all of the relationship for themselves with the teacher supplying encouragement and guidance when needed. This procedure allows for students to self – regulate and therefore move toward equilibrium with the concept introduced.

During the invention activity, students are encouraged to formulate relationships which generalized their ideas and concrete experiences; the teacher acts as a mediator in assisting students to formulate these relationships so as to be consistent with the stated objectives.

In an invention lesson, the classroom environment is democratic and student centred. Students are immersed in experiences within which they may engage in; meaning – making inquiry, action, imagination, invention, hypothesizing and personal reflection. The teacher in the classroom exhibits a number of discernable qualities markedly different from the traditional lecture classroom. He is able to flexibly and creatively incorporate ongoing experience in the negotiation and construction of lessons with small group, individual or whole class.

There are a number of factors within the learner that influence their ability to learn. Perhaps best known of these are cognitive factors such as intelligence and creativity; but there are other factors that can be of equal relevance to the teacher. These factors include: affective

(emotional), maturational, the learner's age, sex and social background, study habits and above all memory. But of importance from the researcher's point of view are the learners' ability and gender to Chemistry Education. The effect of gender on mathematics and science achievement has been a major debate among educators and researchers. For instance; some such as Oyedeji; (1996) and Awofala (2000) have significant gender group difference in favour of male in mathematics and science. This study is particularly interested in gender differences on performance in Chemistry in Nigerian Educational setting where mathematics and some science subjects such as physics and chemistry are given male image (Okpala and Onocha, 1998). It is believed that, if chemistry teaching is handled in a different way, the perception of Chemistry will change for the Students.

Statement of the Problem

There has been persistence decline in students' academic achievement in sciences in Nigeria. Among the reasons adduced for the decline are poor instructional method, inadequate teaching aids and the abstract nature of some concepts in sciences which hinders effective learning and students' achievement. And the most important outcome of science instruction strategy is to promote quantitative and qualitative learning. It is therefore imperative to conduct this research to determine the effect of discussion and invention teaching strategies on student's achievement in chemistry. The study seeks to address this problem: What are the effects of discussion, invention strategies and traditional lecture method in chemistry.

Research Questions

The following research questions raised to guide this study.

1. Is there any effect of discussion strategy on students' achievement of chemistry concepts?
2. Is there any effect of invention Strategy on Students achievement in student ability test of chemistry concepts
3. Is there any effect of discussion and traditional lecture method on students' achievement in chemistry concepts?

4. Is there any effect of invention and traditional lecture methods in chemistry concepts?
5. Will there be any effect on male and female students in the use of discussion and invention teaching strategy on achievement of chemistry concepts?
6. Will there be any effect on achievement of students of varying abilities using discussion and invention strategies?

Research Hypotheses

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

$H0_1$: There is no significant difference in the chemistry achievement between students exposed to discussion, invention and traditional lecture methods.

$H0_2$: There is no significant difference in chemistry achievement between male and female students exposed to discussion, invention and traditional lecture methods.

$H0_3$: There is no significant difference in achievement between students of varying abilities using discussion and invention teaching strategies

Methodology

This study adopted a pre-test, post-test, follow up test, control group quasi-experimental design. For the purpose of the analysis of the research data; a 3x2x2 factorial matrix was employed.

Research Instrument

The study made use of the following instruments Instructional unit

(i) Chemistry Achievement Test (CAT)
(ii) Ability test in chemistry (ABT)
(iii) Teachers Instructional package

Validation of instrument

The chemistry achievement test (CAT) and the ability test(ABT) were validly tested and reliability coefficient estimate were obtained as follows CAT 0.84 and ABT 0.85 using Kuder Richadson KR 20 formula.

Data Analysis

The data obtained from the study were analyzed using the inferential statistics of analysis of covariance (ANCOVA) and variance. This was done to determine the group difference using the pre-test scores as covariate. Multiple classification analysis (MCA) was used to find out whether there was significance or not. To determine the actual source of the significant difference if any, Scheffe post hoc test was performed on the mean scores of the group.

Discussion and Findings

HO_1: There is no significant difference in the chemistry achievement among students exposed to Discussion, Invention and traditional lecture methods. The following tables 1.1, 1.2 and 1, 3 are the results of analysis in respect of hypothesis 1.

Table 1.1

		Value	N
Treatment	1	Control	72
group	2	Experimental group 1 (Discussion)	72
	3	Experimental group 2 (invention)	80

Table 1.2: Descriptive statistics showing the means and standard deviations

Treatment groups		Mean	Std. Deviation	N
Achposttest:	control	17.03		72
	experimental group 1 (Discussion)	19.65		72
	Experimental group 2 (invention)	21.14	4.497	80
	Total	19.34	4.692	224
Follow up test:	control	10.85	4.120	72
	experimental group 1 (Discussion)	16.56	4.779	72
	experimental group 2 (invention)	.18.04	5.413	80
	Total	15.25	5.714	224

Table 1.3 Summary of ANCOVA of Post – test and the follow-up test (Achievement test) scores by Treatment.

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	Achposttest	4040. 146[a]	3	1346.715	340.522	.000
	Follow up test	5868.481[b]	3	1956.160	304.457	.000
Intercept	Achposttest	2311.753	1	2311.753	584.535	.000
	Follow up test	551.524	1	551.524	85.839	.000
AchpretestAchposttest		3389.683	1	3389.683	857.094	.000*
	Follow up test	3728.466	1	3728.466	580.298	
TrtgroupAchposttest (combined)		583.478	2	291.739	73.767	.000*
Follow up test		1952.401	2	976.201	151.936	.000*
Error	Achposttest	870.068	220	3.955		
	Follow up test	1413.519	220	6.425		
Total	Achposttest	88688.000	224			
	Follow up test	59376.00	224			
Corrected Total	Achposttest	4910.214	223			
	Follow up test	7282.000	223			

a. R Squared = .823 (Adjusted R Squared =. 820)
b. R Squared = . 806 (Adjusted R Squared = 803)
* Significant at P < .05

From Table 1.3, treatment had a significant effect on students achievement ($F_{(2.820)} = 73.767$; $P<.05$). This means that students exposed to Discussion; Invention and conventional traditional lecture method differ significantly on their Posttest scores. Hence hypothesis 1 is rejected.

Table 1.2 provides answers to research question one, two, five and six. This shows that students in the Invention instructional strategy obtained higher adjusted Posttest mean achievement score (X = 21. 14) than those exposed to Discussion strategy (X = 19.65) and control (conventional Traditional method (X = 17.03) respectively. This implies that invention instructional strategy was most effective on students' achievement, followed by the Discussion strategy, while the conventional traditional method was the least effective.

Ho2: There is no significant difference in chemistry achievement between male and female student exposed to Discussion and invention teaching strategies.

The tables below, 1.4, 1.5, 1.6, 1.7, 1.8 provide answers to Hypothesis 2 and research questions seven.

Table 1.4: Distribution between Male and female

		Value Label	N
Gender	1	Male	119
	2	Female	105

Table 1.5: Descriptive statistics showing Gender; mean and standard deviations

Gender		Mean	Std. Deviation	N
Achposttest	male	19.57	4.642	119
	female	19.08	4.757	105
	Total	19.34	4.692	224
Follow up test	male	15.62	5.824	119
	female	14.83	5.586	105
	Total	15.25	5.714	224

Table 1.6; Summary of ANCOVA of Post-test and the follow up test of male and female scores by treatment.

Source	Dependent Variable	Type III Sum of squares	Df	Mean Square	F	Sig.
Corrected Model	Achposttest	3463.463[a]	2	1731.732	264.533	.000
	Follow up test	3938.764[b]	2	1969.382	130.183	.000
Intercept	Achposttest	2312.763	1	2312.763	353.289	.000
	Follow up test	517. 776	1	517.776	34.227	.000
Achpretest	Achposttest	3449.782	1	3449.782	526.975	.000
	Follow up test	3903.662	1	3903.662	258.046	.000
Gender	Achposttest	6.795	1	6.795	1.038	.309*
	Follow up test	22.684	1	22.684	1.499	.222*
Error	Achposttest	1446.751	221	6.546		
	Follow up test	3343.236	221	15.128		
Total	Achposttest	88688.000	224			
	Follow up test	59376.000	224			
Corrected Total	Achposttest	4910.214	223			
	Follow up test	7282.000	223			

a. R Squared = .705 (Adjusted R Squared = .703)
b. R Squared = .541 (Adjusted R Squared = .537)

Table 1.8 showed that there is no significant effect of Discussion and Invention strategies on male and female students achievement ($F_{(1.708)}$ =1.038; p < .05 in chemistry. The same table shows there is no significant effect of male and female students on retention ($F_{(1.537)}$ = 1.499 p < .05) in chemistry. Hence hypothesis 3 is accepted.

Ho3: There is no significant difference among student of varying abilities using Discussion and Invention teaching strategies. The following tables 1.9 and 1.10 are the results of analysis in respect of hypothesis 3 and research question 3

Table 1.7: Test of Between-Subject Effects

Summary of ANCOVA of Ability on Students Achievement / Retention Chemistry

Source Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
corrected model	283.531a	12	23.638	6.920	.000
Abpost	444.131b	12	37.011	7.253	.000
Abfollow-uptest					
Intercept	11266.459	1	11266.459	3299.633	.000
Abpost	9253.161	1	9253.161	1813.320	.000
Abfollow-uptest					
AbpretestAbpost	181.267	1	181.267	53.088	.000
Abfollow-uptest	231.130	1	231.130	45.294	.000
Rent	76.093	11	6.918	2.026	.027
Abpost	167.037	11	15.185	2.976	.001
Abfollow-uptest					
Error	720.451	211	3.414		
Abpost	1076.708	211	5.103		
Abfollow-uptest					
Total	54882.000	224			
Abpost	44036.00	224			
Abfollow-uptest					
Corrected Total	1003.982	223			
Abpost	1520.839	223			
Abfollow-uptest					

a. R Squared = .282 (Adjusted R Squared = .242)
b. R Squared = .292 (Adjusted R Squared = .252)

Table 1.7 shows that there is significance difference in retention among students of varying abilities taught with discussion and invention teaching strategies both in Posttest and follow-up test ($F_{(11.242)} = 2.026$; $P<.05$) and $F_{(11.252)} = 2.976$. Therefore the hypothesis is rejected

Table 1.8; Summary of ANCOVA of students' Ability on Retention in chemistry

Tests of Between-Subjects Effects

Dependent Variable Retention

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	429.199a	3	143.066	37.163	.000
Intercept	565.047	1	565.047	146.778	.000
Ability	2.929	1	2.929	.761	.384
trtgroup	413.047	2	206.524	53.647	.000*
Error	846.926	220	3.850		
Total	5204.000	224			
Corrected Total	1276.125	223			

a. R Squared = .336 (Adjusted R Squared = .327)

Table 1.8, equally shows that there is significant difference in ability of students' retention in chemistry. $F_{(2.327)} = 53.647$; $P< .05$) is significant. The hypothesis is further rejected.

Table 1.9: Between-Subjects Factors: Descriptive statistics of Ability scores on Achievement in chemistry.

		N
Rent	0	16
1		9
2		39
3		31
4		27
5		35
6		25
7		22
8		12
9		6
10		1
11		1

Discussion of Results

The finding of the study in Tables 1.1, 1.2, 1.3 and 1.4 revealed that there is significant main effect of treatment on the academic achievement of students exposed to Discussion and invention strategies. This could be due to the fact that teaching Chemistry with the Discussion and invention strategies employed group learning effort. This means that there is a free flow of information from the teacher to the students; students to teacher and student to students; it ensures that all students participated to bring about learning. This supports the assertion of Unuero 2006 that teaching method and instructional strategy adopted by the teacher played a role as a classroom variable in affecting students' achievement.

The benefit of Discussion, as stated by Grouws and Cebulla (2000), are the promotion of the learning of academic skills, the development of social behaviours and classroom discipline, the enhancement of group relations, the promotion of metacognition in which students achieve higher levels of thinking at a quicker rate than if they worked independently and improvement of students achievement. This explains why Discussion strategy was significantly better than the conventional method.

The finding shows that when students discover concepts, ideas and invent chemical procedures; they have a stronger conceptual understanding of connections between chemical ideas. The reason for

improved achievement and positive retention of chemistry concepts could be because students were exposed more to concrete objects in learning chemistry.

The details of the results as shown in table 1.3, revealed that subjects exposed to invention strategy performed significantly better in achievement mean scores than those exposed to Discussion, while the conventional method was least effective. This equally supports the assertions of Simpson and Troost in Okurumeh (2009). Cobb, Yockel and Wood; (1992); Wood (1993) in their studies that shown, when students have opportunities to develop their own solution lines and methods, they are better able to apply scientific knowledge in new problem situation.

The low performance of students in the conventional strategy (control) group in the posttest achievement mean scores compared with other treatment groups may not be unconnected with the fact that the strategy is teacher – centered. The conventional strategy has been found not to be suitable at identifying the various needs of students; as every typical class is made up of students with mixed ability. The conventional strategy does not offer students opportunities to develop their ability to communicate, think and solve problem (Ezenweani; 2002; Unuero; 2006). The criticisms and reasons for lack of preference for the conventional strategy are overwhelming; nevertheless, some research findings are in support. Those in support include Gagne; Parking and Hills (1993); they noted that the conventional strategy is administratively convenient, a good method of assembling staff and students in a place at a time so that a certain amount of material can be covered. However most of these supporters are foreign researchers and their studies were conducted at tertiary institutions as against those conducted at the secondary schools in Nigeria.

Finding of the study also indicated that there is no significant main effect of students' gender on achievement in chemistry. The performance of males was not significantly different from that of the females in this study. Though, a number of researches have been carried out in the past on the effect of gender on achievement in physical sciences, many of which revealed that males tended to perform better than females.

For instance Okpala and Onocha (1998), Aiyedun (2000), Unuero (2006) have found significant gender group difference in favour of males. This study; however; agreed with studies such as that of Oyedeji (1992) and Iroegbu (1998), Okurumeh (2009) which did not establish such difference.

Summary and Conclusion

1. There were significant effects of treatment; on student; achievement in chemistry. Students in the two treatment groups obtained higher posttest mean scores; than those in the control group both in Achievement.
2. There was no significant effect of treatment on gender of Senior Secondary Students achievement and Retention in chemistry concepts.
3. There was no significant effect of treatment on Ability of Senior Secondary Students Achievement and Retention of chemistry concepts.

Based on the findings of this study; the following conclusions are drawn.

* The two instructional strategies (Discussion and Invention) were very effective in promoting students achievement in chemistry than the conventional method. However, the Invention strategy proved more effective but both are significant.
* The two instructional strategies (treatment) could be used to affectively improve achievement in chemistry.
* The two instructional strategies (treatment) could bridge the gap in terms of performance between the low medium and high abilities groups.
* Invention strategy is a good strategy for promoting and improving chemistry achievement of boys and girls.
* It was also found that the conventional (traditional) teaching method amplified gender disparity in achievement in chemistry.

This study has redefined the role of chemistry teacher on the choice and use of instructional strategies to improve, promote achievement and ability in chemistry in Nigeria Senior Secondary Schools.

The Discussion and Invention teaching strategies could be a frame work/model for planning lessons for chemistry teaching in senior secondary Schools

- The two instructional strategies (treatment) bridge the gap between the low, median and high abilities groups in terms of performance (achievement) in chemistry.

Recommendations

Based on the findings the following recommendations are made

- Teachers of chemistry should be trained in the use of discussion and invention strategies for teaching chemistry
- Seminars and workshops should be organized for serving/practicing teachers of chemistry on the effective of the instructional strategies for chemistry instruction.
- Textbooks writers with help of curriculum planners could incorporates exercises and techniques that will promote discussion and invention methods
- The two strategies should form a framework/model for planning lessons for chemistry teaching in secondary schools

References

Adeoye, F.A. (2000). Assessment procedure, cognitive style and Gender as determinants of students performance in Hierarchical cognitive tasks in Physics. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Ajaja, O.P. and Kpangban E. (2000).Enriching Biology Teaching in the 21st Century in Nigeria. Implications for Teachers.*Journal of the Science Teachers Association of Nigeria* 33 (2) 38 -39

Alebiosu, K.A. (1998). Effects of two cooperative learning outcome in Chemistry. Unpublished Ph.D. Thesis University of Ibadan.

Alele-William, G. (1986); Education for women for national development. A key note address at a workshop on women's education in Nigeria; Federal Ministry of Education; Lagos.

Awofala; A.O.A; (2000). The status of mathematics teaching and Learning in primary school at the year 2000: (unpublished B.Ed project); University of Ibadan, Nigeria.

Balogun T.A. (1994); Gender issues in the teaching of STM in Erinosho S.Y. (Ed); *Perspective on women in science and technology in Nigeria;* Ibadan*;* Sambookman Educational and communication services.

Cobb, P, Yackel, E and Wood; T. (1993). A constructivism alternative to Representational view of mind in mathematics education.*Journal for research in mathematics education 23; 2-23.*

Esan A.O. (1999). Effects of cooperative and individualistic problem – solving strategies on students learning outcomes in Secondary School Mathematics, unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Ezenweani U.I. (2002). Experimental Teaching. Enugu Fulladu Publishing Company (1 – 47)

Gagne N.L. (1968) " An Analytical Approach to Research in instructional methods. *The Journal of Experimental Education* 37: 118 – 123.

Geoffrey, P.(2001). Teaching Today- A practical guide . (2nded). Nelson Thornes Ltd; Delta place 27; Bath Road Cheltenham; G1537th United Kingdom.

Growns; D.A and Cebulla; K.J (2000). Improving students Achievement in Mathematics. Geneva Switzerland: international academy of education. University, Columbus, Ohio.

Igwe, I.O. (2001). Relative Effects of Framing and Team assisted Instructional Strategies on Students learning outcomes in selected difficult Chemistry concept *Unpublished Ph.D Proposal, University of Ibadan.*

Ikeobi; A.N; (1983).Concept of interaction of the sciences in Nigeria. *Journal of research in curriculum. 4(1); 85-97.*

Iroegbu; T.O. (1998). Problem based learning; Numerical ability and Genders As Determinants of Achievement in line graphing skills in senior Secondary physics. *An unpublished Ph.D Thesis; University of Ibadan; Ibadan; Nigeria.*

Kempa, R and Aminah, A. (1991) Interactions in group work in Science; *International Journal of Science Education*, 13(3), PP 341 – 354

Khan, A.S and Saeed, S. (2010). Effects of teaching Chemistry through "concept formulation teaching model" on student's achievement. *International journal academic research*; 2(6) 230 – 234.

Kpeke; E.E and Osho, I (1997). Approaches; Methods; Strategies and Techniques of teaching in Inomiesa; E.A. and Osakwe; E.O(Ed). *Principles and practice of teaching for students in tertiary institutions.* Pp 32 – 50 About research publishers; Delta State.

Murphy; E. (1977). Characteristics of constructivists learning and teaching university Laval; Quebec; Retrievedfrom. Http://www. statement.nf. calelmurphy/clez.html.

Odunsi T.O. (2009). Women in Science, Technology and Mathematics Education in Nigeria. An Alternative Strategy. 42nd Annual Conference Proceeding of STAN.

Okpala, M.P. and Onocha (1988).Students factors as correlation of Achievement in Physics Education. *A Journal of Physics Institute;* 23 (5).

Ojo, M.O. (1989). The differential Effectiveness cooperative Competitive and individual's Goal Structure on students' Performance in Chemistry.*Unpublished Ph.D Thesis, University of Ibadan.*

Ochonogor; E.C. and Ajaja; O.P; (2005). Teaching Methods-A Multi-disciplinaryObielum Nigeria Enterprise. P; Oshindero Street; Odo-eran; Itire; Surulere; Lagos; Nigeria.

Oludipe, D. and Awokoye, J.O. (2010) Effects of Cooperative Learning Teaching Strategy on the Reduction of Students Anxiety for Learning Chemistry. *Journal of Turkish Science Education* (7) 1, 30-36

Osokoya; M.M. (2002) Modern trends in the teaching of Secondary Schools Chemistry. In Ayodele; S.O (Ed) *Teaching strategies for Nigeria secondary school.*

Oyedeji; O.A (1996). Assessing Gender factors in some science and Mathematics Test in Nigeria; *Zimbabwe Journal of education*

Unuero, J.U (2006). Comparative study of guided discovery; lecture and concept mapping methods of teaching geometry in secondary schools *Unpublished Ph.D Thesis. Delta State University; Abraka Nigeria.*

UNESCO – UNEP (1990) Environmentally Educated Teachers: The priority of Priorities, *Connect* XV(1); 1 - 3

Vygotsky, L.S. (1978). Mind in society: The Development of Higher Mental Processes. Cambridge; M.A: Harvard University Press

WAEC, 2009, 2010, 2011, 2012; chief examiners reports on the performance of candidates in chemistry. Yaba, Lagos.

Wilson, J.W; Fernandez, M.L; Hadaway, N. (2006); mathematical problem solving, retrieved 11/09/2006 PSsyn.html.

Wood, T. Cob, P and Yackel; E. (1991). Small group interactions as a source of learning opportunities in second grade Mathematics Education. (Reston VA) vol. 22 P390-408.

Yoloye, E.A (1980). Developing and understanding of Education. Ibadan University Publishing Home

Zemelman; S.D. and Hyde; A. (1993). Best practice: New standard for teaching and learning in American Schools. Portsmouth; NH Heinemann.