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Effects of mastery learning strategy on students' achievement in symbols, formulae and equations in chemistry

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Abstract. This study investigated the effectiveness of mastery learning strategy in facilitating students' achievement on the concepts of symbols, formulae and equations in chemistry compared with the traditional expository method given their gender and interest in the subject. It was a quasi-experimental study conducted in selected co-educational secondary schools in Nsit Ibom and Ibesikpo-Asutan Local Government Areas of Akwa Ibom State, Nigeria, using one hundred and eighty three SS2 chemistry students as sample. Three research questions were raised for answering and three null hypotheses were formulated for testing. Two researcher-developed instruments - Achievement Test on Chemistry (ATC), a 25 item, 4-option multiple choice test drawn from the concepts of Symbols, Formulae and Equations, and Students' Interest Scale (SIS), a 20 item Likert scale developed for assessing students' interest in chemistry with reliability co-efficient of .80 and .76, respectively, were used for data collection. Data collected were analysed using Analysis of Covariance (ANCOVA). The results of analyses of data showed that students taught using mastery learning strategy performed significantly better than those taught using the traditional expository method; and that gender had a significant influence on the students' performance with the males outperforming their female counterparts. However, students' interest was not observed to be a significant determinant of the students' performance. Consequently, it was recommended that teachers of chemistry should always adopt mastery learning strategy in teaching these concepts; and that earnest efforts should always be made to ensure gender friendly science classrooms.

Keywords: Mastery learning strategy, traditional expository method, students' interest, students' gender, students' achievement on the concepts of symbols, formulae and equations.

INTRODUCTION

The growing awareness of the contributions of science and particularly chemistry to the socio-economic and technological development of a nation cannot be overemphasized. Science, according to Ogunleye and Babajide (2011), is an instrument for economic, technology and political development. The objectives of the senior secondary school chemistry curriculum include, among others, that students are taught to acquire theoretical and practical skills and develop interest in the subject (FME, 2009). According to Holbrook (2011), students learn science to gain factual knowledge and skills as well as passing subject knowledge examination.

Learning, according to Taber (2009), is a personal activity and each student has to construct his or her own knowledge. For learning to be personalized, it demands that learners should show commitment and interest, as well as actively participate in the learning process for meaningful understanding and assimilation of facts. This implies that learning could be meaningful and effective when students reflect on what is taught; develop interest on the subject matter and construct new knowledge based on their understanding of the concepts. In view of this, science teaching ought to be proactive and student-

centred for meaningful learning and understanding. However, Njoku (2004) observes that science teaching in Nigeria is still done expositorily even when the method used by the teacher neither promotes students interest nor academic achievement; partly because of the teachers' inadequacies and partly because of their reluctance to adopt innovative teaching approaches which had been proved effective in enhancing learning outcomes. This has unfortunately resulted in persistent poor performances of students in the sciences, especially, chemistry because of its abstract nature (Eshiet, 1996).

Several researches have shown that Nigerian science classrooms are bedeviled with lot of challenges; prominent among which are poor teaching strategies adopted by teachers (Udo and Udofia, 2006); students' lack of interest in the sciences (Okigbo, 2010); gender (Udo and Udofia, 2006, 2006; Udo, 2011); students' anxiety (Jegede, 2010) and the abstract nature of chemistry (Eshiet, 1996). The WAEC Chief Examiners Report of May/June 2008 (WAEC, 2008) revealed that 83% of the candidates who sat for the examination that year failed to obtain five credits and above, especially in Mathematics, English and the sciences. Similarly, result of West African Senior School Examinations for May/June, 2011 (WAEC, 2011) in chemistry was equally very poor and WAEC (2011) blamed it on lack of adequate understanding of some chemical concepts. According to the document the candidates demonstrated marked weaknesses in the areas of symbols, formulae and equations, among others. This is because students perceive these chemistry concepts as difficult (Ikeobi, 2010).

It should be noted that the attainment of stated instructional objectives, as well as enhanced students' performance is a collective responsibility of both teachers and students. The selection of appropriate instructional strategy enhances smooth delivery and effective achievement of instructional objectives. Adesoji and Olatunbosun (2008) maintain that chemistry teaching can be result-oriented if students are willing to learn, and appropriate methods are used by the teachers. Thus the method of instructional delivery is a significant variable in the teaching-learning process. It can arouse and sustain the learners' interest thereby ensuring result oriented teaching-learning session. Mastery learning is a remedial process aimed at bringing students to a level of mastering a concept. Adepeju (2003) sees it as an innovative strategy designed to make students perform beautifully very well in an academic task. It involves:

i) Involving the learners in relevant hands-on, hearts-on and heads-on activities;
ii) Frequent assessment and feedback;
iii) Corrections with emphasis on cues;
iv) Motivation;
v) Allotment of more time on tasks; and
vi) Reinforcement through assignments.

From the above it should be noted that mastery learning strategy focuses on students reaching a pre-determined level of mastering a unit before moving to another. Abakpa and Iji (2008) opine that mastery learning strategy can provide quality instruction, immediate feedback and remedial lessons for the attainment of lesson objectives. Studies by Akinsola (2007), and Abakpa and Iji (2008) all affirm that mastery learning strategy enhances students' academic achievement and retention in integrated science and mathematics than the conventional method.

Science classrooms are becoming more diverse with differences in terms of learning environment, students' background, students' interest, and abilities. As earlier noted, interest is a key driving force for students to learn meaningfully. Simply stated, it is a feeling of like or dislike towards an activity or something. Imoko and Agwagah (2006) define interest as persistent tendency to pay attention and enjoy learning. Studies by Campe (2006), and Okoyefi and Nzewi (2013) showed that students perform well when they are exposed to methods that interest them during the teaching-learning process. Hence, innovative instructional strategy, as the mastery learning strategy, could be used to reduce the decline of students' interest in chemistry.

Gender, as a concept, has captured the interest of science educators in Nigeria, especially now that gender equity is being emphasized in Nigerian school science curriculum. The ABC of women's right and gender equality (2000) defines gender as the socially constructed differences and relations between males and females. According to the document the term "gender" is not interchangeable with the term "sex", which refers exclusively to the biological differences between men and women, which are universal and do not change; gender characterizes the differing roles, responsibilities, constraints, opportunities and needs of females and males in all areas and in any given social context.

Studies abound on gender differences and students' achievement in. While some of these studies observed gender disparity in science in favour of males (Ekeh, 2004); others report females' superiority (Shaibu and Mari, 1997) and others still, zero disparity (Udo and Udofia, 2006; Udo, 2010, 2011). Hence, studies on gender and students' performance in science are conflicting and inconclusive. Researchers reporting male dominance explain their observations in terms of cultural factors and gender stereotyping. Owuamanam and Babatunde (2007) in a study on gender role stereotypes and career choice of secondary school students observed that boys showed interest on brain tasking careers while girls were more interested on courses that do not require much brain work. To ensure learner-friendly learning environment, effective instructional method that involves activities with students taking over

their learning should be encouraged. Mastery learning strategy is one of such innovative learner-friendly teaching approach (Adepeju, 2003).

Statement of the problem

Despite growing awareness of the importance of the sciences, especially chemistry, to the socio-economic and technological development of any nation, Nigerian students still perform dismally in both internal and external examinations. Studies indict inappropriate instructional strategies used by teachers, and students' characteristics among others. Rarely do teachers of chemistry use innovative teaching methods which have been proven effective. Science classrooms are becoming more diverse with differences in terms of learning environment, students' background, students' interest, and abilities. Studies (Udo and Udofia, 2006; Jegede, 2010; Okigbo, 2010; Udo, 2010, 2011), show that apart from inappropriate teaching strategies used in communicating science concepts to learners, student variables such as gender, and interest in the subject impact significantly on students' overall achievement in the subject. Studies on gender differences and students' performance are however inconclusive. It therefore becomes necessary to investigate the influences of gender and students' interest on their achievement in selected chemistry concepts when taught with Mastery learning teaching strategy.

Purpose of the study

The purpose of this study was to investigate the effect of mastery learning strategy on students' achievement in the area of symbols, formulae and equations in chemistry given their gender and interest in the subject. Specifically, the study sought to:

1. Determine the effect of mastery learning strategy on chemistry students' achievement in the area of symbols, formulae and equations.
2. Compare the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy.
3. Determine the effect of mastery learning strategy on the achievement of students' of different interest levels in the area of symbols, formulae and equations in chemistry.
4. Determine the interaction effects among teaching methods, students' gender and interest given their achievement on the concepts taught.

Research questions

The following research questions were raised for answering:

1. How do students differ in their achievement in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method?
2. What difference exists between the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy and the conventional lecture method?
3. How do students of different interest levels differ in their achievement in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture on method?

Hypotheses

The following hypotheses were formulated and tested:

Ho_1: There is no significant difference between the achievement of students in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method.
Ho_2: There is no significant difference between the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy and the conventional lecture method.
Ho_3: There is no significant difference in the achievement of students of different interest levels in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method.
Ho_4: There is no significant interaction effects among teaching methods, students' gender and interest given their achievements on the concepts taught.

MATERIALS AND METHODS

The study was a quasi-experimental research and a pre-test – post-test non-equivalent control group design was used. The target population consisted of all secondary school grade level 11 chemistry students in the fifteen coeducational public secondary schools in Nsit Ibom and Ibesikpo-Asutan Local Government Areas of Akwa Ibom State; and the sample consisted of one hundred and eighty three grade level 11 chemistry students drawn from four intact classes from four out of fifteen co-educational schools in the study area.

The instruments used for data collection were two researcher-developed instruments - Achievement Test on Chemistry (ATC) and Students' Interest Scale (SIS). The ATC was a 25 item, 4-option multiple choice test drawn from the concepts of Symbols, Formulae and Equations. The SIS was a 20 item Likert scale developed for assessing students' interest in chemistry. The draft of the

Table 1. Mean and standard deviation scores of the students' pre-test and post-test performances classified by treatment groups.

Treatment groups	Sample size	Pre-test	Post-test	Mean diff.
		X Sd	X Sd	
Mastery learning (Experimental)	92	13.61 2.72	74.96 10.24	61.35
Conventional lecture method (Control)	91	13.05 3.36	31.85 4.38	18.80
Total	183	13.33 3.06	53.52 23.00	40.19

two instruments - ATC and SIS, which contained 40 and 30 items respectively, were submitted to three experienced chemistry teachers in secondary schools and two chemistry lecturers from the Department of Science Education, University of Uyo, Uyo, for face and content validation. They were specifically requested to check for the appropriateness of the items and content coverage considering the grade level and the objectives of the study. Based on their comments and suggestion, which included revising some of the items and dropping some, the number of items was reduced in ATC from 40 to 30 items, and in SIS from 30 to 20 items. To further strengthen the validity of the ATC, the 30 remaining items were trial tested on a sample of 40 grade level 11 chemistry students in a school in the study area not selected for the study. The data obtained were used to determine the difficulty and discrimination indices of the items. For the purpose of this work items with difficulty indices below .25 were deleted for being difficult and those above .75 were also deleted for being too simple (Anikweze, 2010). With respect to the discriminating powers or item efficiency, only items with discriminatory indices ranging between .25 and .70 were accepted, those outside this range were deleted for lacking the powers to discriminate between the slow and fast learners. These further reduced the number of items from 30 to 20 items in the final form of ATC.

Thereafter, the reliability co-efficient of ATC was determined using test-retest method while that of SIS was determined using Cronbach's Alpha reliability index. For test-retest measurements, the second test, a reshuffled version of the first, was administered two weeks after the first to the same set of grade level 11 students in the study area not selected for the main study, and the data obtained were analysed using Pearson Product Moment Correlation (PPMC). The results indicated that ATC had a reliability index of .80. The Cronbach's Alpha reliability index of SIS was .76. These observations showed that these instruments were reliable and capable of measuring the intended events with consistency.

Two validated researcher-developed instructional packages (one for the experimental group taught using Mastery learning and the other for the conventional lecture method group) were used for teaching the selected concepts to the two groups. The subject teachers in the selected schools who were experienced graduate teachers with at least BSc. Degree in chemistry education were used as research assistants after training for one week using the instructional packages for their respective groups. This was followed with administration of ATC as pre-test and SIS for measuring the students' interest in the subject. After pre-test the research assistants taught the selected concepts to their respective groups during their normal class periods for the course for three weeks. Each class period was of 40 min duration and for the three weeks a total of nine periods were used. This was quite adequate considering the content area investigated. The teaching was closely supervised by the researcher after which a reshuffled version of ATC was administered as post-test to both the experimental and control groups. The data collected were analysed using mean, standard deviation and Analysis of Covariance (ANCOVA), using pre-test as the covariate. ANCOVA was considered most appropriate since the subjects were treated in their intact class setting.

RESULTS

The results for answering the 3 research questions raised are summarized in Table 1 while those for testing the 3 hypotheses which guided the study are summarized in Tables 2 and 3.

Research question 1

How do students differ in their achievement in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method?

In Table 1, the mean scores of the students in the mastery learning strategy group and the conventional lecture method groups on pre-test and post-test are 13.61 and 74.96 respectively. These results give a post-test - pre-test mean difference of 61.35; while those of the students in the conventional lecture method (control) group are 31.85 and 13.05 respectively, giving a post-test - pre-test mean difference of 18.80. The gains in scores show that the students in the experimental group taught by mastery learning strategy (43.35) performed better than their counterparts in conventional lecture method

Table 2. Mean and standard deviation scores of the students' pre-test and post-test performances classified by treatment groups and gender.

Treatment groups	Gender	Sample size	Pre-test	Post-test	Mean difference
			X Sd	X Sd	
Mastery learning (Experimental)	Male	43	14.51 2.62	78.79 10.92	64.28
	Female	49	12.82 2.58	71.59 8.34	58.77
	Total	92	13.61 2.72	74.96 10.24	61.35
Conventional lecture method (Control)	Male	44	13.64 3.26	31.91 4.69	18.27
	Female	47	12.51 3.40	31.79 4.13	19.28
	Total	91	13.05 3.36	31.85 4.38	18.80
Total	Male	87	14.07 2.98	55.08 25.00	41.01
	Female	96	12.67 3.00	52.10 21.06	39.43
	Total	183	13.33 3.06	53.52 23.00	40.19

Table 3. Mean and standard deviation scores of the students' pre-test and post-test performances classified by treatment groups and interest.

Treatment groups	Interest	Sample size	Pre-test	Post-test	Mean difference
			X Sd	X Sd	
Mastery learning (Experimental)	High	39	13.94 2.73	73.95 8.55	60.01
	Low	53	13.36 2.71	75.70 11.34	62.34
	Total	92	13.61 2.72	74.96 10.24	61.35
Conventional lecture method (Control)	High	41	13.37 3.18	31.17 4.17	17.80
	Low	50	12.80 3.52	32.40 4.52	19.60
	Total	91	13.05 3.36	31.85 4.38	18.80

group (18.80). Considering research question one - How do students differ in their achievement in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method? – the observations indicate that students taught using mastery learning strategy did better than those taught with the conventional teacher-centred expository methods.

Research question 2

What difference exists between the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy and the conventional lecture method?

With respect to performance by gender, Table 2 shows that the post-test and pre-test means of the males in the mastery learning strategy and the conventional lecture method groups were 78.79 and 14.51; and 31.91 and 13.64 respectively, while those of their female counterpart in the mastery learning strategy and the conventional lecture method groups were 71.59 and 12.82; and 31.79 and 12.51 respectively. A comparison of these performances indicates that both the males and the females in mastery learning strategy group had a better performance than those in the expository group. These observations answered research question two – What difference exists between the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy and the conventional lecture method?

Research question 3

How do students of different interest levels differ in their achievement in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture on method?

With respect to performance by students' interest, Table 3 shows that the post-test and pre-test means of the students with high interest in the mastery learning strategy and the conventional lecture method groups were 73.95 and 13.95; and 31.17 and 13.37 respectively, while those of their counterpart with low interest in both

Table 4. Summary of Analysis of Covariance (ANCOVA) of students' post-test performance classified by treatment, gender and interest with pre-test as covariate.

Source of variation	Sum of squares	df	Mean square	F-cal	Sig.	Decision at p <.05 level
Covariate: Pre-test	185.18	1	185.18	3.30	.07	ns
Main effects:						
Instructional Methods	81863.67	1	81863.67	1458.61	.00	s
Gender	462.01	1	462.01	8.23	.01	s
Interest	115.45	1	115.45	2.06	.15	ns
2-way interactions						
Methods*Gender	527.62	1	527.62	9.40	.00	s
Methods* Interest	1.84	1	1.84	.03	.86	ns
Gender* Interest	11.09	1	11.09	.20	.66	ns
3-way interactions						
Methods*Gender* Interest	11.03	1	11.03	.20	.66	ns
Residual	9765.68	174	56.13	-	-	-
Total	96285.68	182	-	-	-	-

R Squared = .899 (Adjusted R Squared = .894)

the mastery learning strategy and the conventional lecture method groups were 75.70 and 13.36; and 32.40 and 12.80 respectively. A comparison of these performances indicates that in both the mastery learning strategy and the conventional lecture method group those with high interest performed better than those with low interest. These observations answered research question two – How do students differ in their achievement in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method based on interest?

Research hypothesis 1

There is no significant difference between the achievement of students in chemistry when taught with mastery learning strategy and with the conventional lecture method.

In Table 4, the calculated F-ratio for the main effect of instructional strategy at df 1, 174 is 1458.61, while its corresponding significant level is .00 alpha. This significant level is less than .05, indicating that the instructional strategies adopted had a significant effect on the achievement of the students in chemistry. Hence, hypothesis which states that, 'there is no significant difference between the achievement of students in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method', was rejected. In Table 1, the results showed that those taught by mastery learning strategy performed significantly better than their counterparts taught with conventional lecture method (mean diff. = 43.35 and 18.80, respectively). That is, mastery learning strategy is more effective than the traditional expository method.

Research hypothesis 2

There is no significant difference between the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy and the conventional lecture method.

With respect to Hypothesis 2, the results in Table 4 showed that the calculated F-value for the main effect of gender at df 1, 174 is 8.23 while its corresponding significance level is .01 alpha. The observed significant level is less than .05 on which the decision is based. This indicates that the influence of gender on students' performance in chemistry is statistically significant considering the teaching methods used. Hence, this hypothesis which states that 'There is no significant difference between the mean scores of male and female students in the area of symbols, formulae and equations in chemistry when taught using mastery learning strategy and the conventional lecture method' - was rejected. The mean scores of 55.08 and 52.10 for the male and female students, respectively, in Table 2 show that the males outperformed their female counterparts.

Research hypothesis 3

There is no significant difference in the achievement of

students of different interest levels in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method.

With respect to Hypothesis 3, the results in Table 4 showed that the calculated F-value for the main effect of students' interest at df 1,174 is 2.06 while its corresponding significance level is .1 alpha. The observed significant level is greater than .05 in which the decision is based. This indicates that the influence of students' interest on their performance in chemistry is not statistically significant considering the teaching methods used. Hence, Hypothesis 3 which states that 'There is no significant difference in the achievement of students of different interest levels in the area of symbols, formulae and equations in chemistry when taught with mastery learning strategy and with the conventional lecture method' - was upheld.

Research hypothesis 4

There is no significant interaction effects among teaching methods, students' gender and interest given their achievements on the concepts taught.

As regard this hypothesis, the results in Table 4 showed that there was a significant interaction effect between the teaching methods used and the students' gender, $F(1,174) = 9.40$, $p = .00$; that there was no significant interaction effect between the teaching methods used and the students' interest, $F(1,174) = .03$, $p = .86$; that there was no significant interaction effect between the students' gender and interest, $F(1,174) = .20$, $p = .66$; and that there was no significant interaction effect among the teaching methods used and the students' gender and interest, $F(1,174) = .20$, $p = .66$.

DISCUSSION

This study investigated the relative effectiveness of mastery learning strategy in facilitating students' achievement in the area of symbols, formulae and equations in chemistry compared with the conventional lecture method given their gender and interest in the subject. The results in Tables 1, 2, 3 and 4 showed that students taught using mastery learning strategy performed significantly better than those taught using the traditional expository method; and that gender had a significant influence on the students' performance with the males outperforming their female counterparts. However, students' interest was not observed to be a significant determinant of the students' performance.

The better performance of students taught using mastery learning strategy compared with those taught with expository method, which agrees with the findings of Akinsola (2007), underscores the importance of involving the learners in constant drills and practice until they master the given concept (Adepeju, 2003). The significantly better performance of the males compared with their female counterparts observed in this study, which supports Shaibu and Mari (1997), and Owuananam and Babatunde (2007), is explained in terms of cultural factors and gender stereotyping. As observed by Owuananam and Babatunde (2007) the females are less interested on brain tasking careers but more interested on courses that do not require much brain work.

With respect to the interaction effects among the variables, the observations showed that only method-gender interaction was statistically significant. These observations indicated that the effects of the teaching methods used were not the same at all levels of gender, whereas, it was the same at all levels of the students' interest, and vice versa.

Conclusion

Consequent upon the findings from this study, it is hereby concluded that mastery learning strategy is more effective in facilitating students' achievement in chemistry than the conventional lecture method; and that gender is a significant determinant of the students' performance in chemistry whereas students' interest is not. The implications of these observations are that teaching strategies adopted by science teachers and students' gender are significant predictors of students' performance. Consequently, it is recommended that teachers of chemistry should always adopt mastery learning strategy in teaching these concepts; and that gender factor should not be overlooked in any teaching-learning situation, hence, earnest efforts should always be made to ensure gender-friendly science classrooms.

REFERENCES

Abakpa BO, Iji CO (2011). Effect of Mastery Learning Approach on Senior Secondary School Students Achievements in Geometry. J. Sci. Teach. Assoc. Niger. 46(1):165-176.

ABC of women right's and gender equality (2000). http://www.ilo.org/wcmsp5/groups/public/---dgreports/---gender/documents/ publication/wcms_087314.pdf

Adepeju AA (2003). Mastery learning strategy and secondary school teaching. *In SO Ayodele (Ed.).Teaching strategies for Nigerian secondary school* Ibadan: Power House Press Publications. pp. 85-92.

Adesoji FA, Olatunbosun S (2008). Student, teachers and school environmental factors as determinants of achievement in secondary school Chemistry in Oyo State, Nigeria. J. Int. Soc. Res. 1(2):13-34. Retrieved June 18, 2012 from http/www.sosyalarastirmalar .com/sosyalarastirmalar_ english/index_eng.htm

Akinsola MK (2007). Mastery learning, cooperative mastery learning strategies and student' achievement in integrated science. Retrieved

on September 20, 2011 from *http/www.ipn.unikiel. deprojket/ esenal /book/1132*

Anikweze CM (2010). Measurement and evaluation for teacher education (2nd Edition).Enugu: SNAAP Press Ltd.

Campe TR (2006). The effect of the 4MAT method (learning styles and brain hemisphere) of instruction on achievement in mathematics. Int. J. Math. Educ. Sci. Technol. *40* (8):1027-1036. http://dx.doi.org/10.1080/00207390903121750

Ekeh PU (2004). Gender bias and achievement in Science and Mathematics among Primary School Pupils: Implications for human resource development. J. Curr. Organ. Niger. 11(2):30-33.

Eshiet IT (1996). Models in chemistry teaching. In I T Eshiet (Ed.) Methodology of science teaching: Historical and conceptual approach. Abak: Belpot (Nig.) Co. pp. 109-114.

Federal Ministry of Education, FME (2009). Senior Secondary Education Curriculum, Chemistry for SS1-3. Abuja: Nigerian Educational Research and Development Council (NERDC).

Holbrook J (2011). Enhancing scientific and technological literacy (STL): A major focus for science teaching at school. J. Sci. Teach. Assoc. Niger. 46(1):9-34

Ikeobi IO (2010). Beyond the stereotype: Thoughts and reflections on education. Lagos: The CIBN Press ltd.

Imoko IB, Agwagah UNV (2006). Improving students interest in mathematics through concept mapping technique: A Focus on gender. J. Res. Curr. Teach. 1(1):30-38.

Jegede SA (2010). Students' anxiety towards the learning of chemistry in some Nigerian secondary schools. Educ. Res. Rev. 2(7):193-197 Retrieved 17 0ctober 2012 from http://www.academicjournals.org /ERR

Njoku ZC (2004). Fostering the application of science educational research findings in Nigeria classrooms: Strategies and needs for teachers' professional development. *In MAG Akale (Ed), 45th Annual Conference Proceedings of Science Teachers' Association of Nigeria,* Ibadan, HEBN Publishers Plc pp. 217-222.

Ogunleye BO, Babajide VFT (2011). Generative instructional strategy enhances senior secondary school students' achievement in physics, Eur. J. Educ. Stud. 3(3):453-463.

Okigbo EC (2010). Comparative effectiveness of mathematical game and instructional analogy as advance organizers on students' achievement and interest in mathematics. Unpublished doctoral dissertation, Nnamdi Azikiwe University, Awka, Nigeria.

Okoyefi QO, Nzewi UM (2013). Effect of 4 Mode Application (4MAT) instructional model on students, achievement and interest in Basic science. In O. Abonyi (Ed.) 54th Annual conference proceedings of Science Teachers association of Nigeria. Ibadan. HEBN Publishers Plc. pp.167- 176.

Owuananam TO, Babatunde JO (2007). Gender role stereotypes and career choice of secondary school students in Ekiti State. J. Educ. Focus. 1(1):103-110.

Shaibu AAM, Mari JS (1997). Gender Related Difference in the Understanding of Science Process Skills among Junior secondary School Students in some Nigerian Schools, J. Sci. Teach. Assoc. Niger. 32(1&2):21-28.

Taber KS (2009). Learning from experience and teaching by example: reflecting upon personal learning experience to inform teaching practice. J. Cambridge Stud. 4(1):82-91.

Udo ME, Udofia TM (2006). Graphics and students' performance in chemistry in Uyo Local Government Area of AkwaIbom State. Int. J. Educ. Dev. 9(2):99-107.

Udo ME (2010). Effects of guided – discovery, student – centred demonstration and expository instructional strategies on students' performance in Chemistry. African Research Review: An Int. Multidiscip. J. Ethiop. 5(4):389-398.

Udo ME (2011). Effects of reformulation of knowledge and expository teaching strategies on students' performance in chemistry. African Research Review: An Int. Multidiscip. J. Ethiop. *5*(1):354-364.

WAEC (2008). Chief Examiner's Report for May/June West African Senior Secondary School Certificate Examination, Yaba, Lagos, Nigeria.

WAEC (2011). Chief Examiner's Report for *May/June West African* Senior Secondary School Certificate Examination, Yaba, Lagos, Nigeria.