

## EFFECT OF GENDER ON MEAN ACHIEVEMENT SCORE OF CHEMISTRY STUDENTS TAUGHT USING MEND MAPPING TEACHING STRATEGY (MMTS) IN ENUGU

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### Abstract

*This study seeks to determine the effect of gender on mean achievement score of chemistry students taught using mind mapping teaching strategies in Enugu. The study sought to specifically study the following objectives; to investigate the difference in mean achievement score of students taught using MMTS and those taught without it; to ascertain the difference that exists in mean achievement score of male and female students taught using MMTS and to determine the interaction effect of gender and treatment on mean achievement score of students taught using MMTS and those taught without it. A quasi experimental, non-equivalent, non-randomized pre-test post-test research design was adopted. The population of the study was 4,698 SS2 chemistry students in Enugu Educational Zone in 2008/2009 academic session. The sample was 194 SS2 chemistry students drawn through multistage sampling technique. The instrument Chemistry Achievement Test (CAT) was developed by the study and validated by two University experts in measurements and evaluation and two university experts of Chemistry Education. The instrument was trails tested at secondary schools in Enugu Education Zone in Enugu State. The internal consistency of the CAT was obtained using Kuder Richardson formula 20(KR-20) and Cronbach alpha procedure. Reliability coefficients of 0.8359 was obtained for the CAT. Mean and standard deviation scores were used to answer the two research questions while the three null hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA). Results showed that MMTS was more effective in facilitating students' achievement in chemistry than the control group. Gender was a significant factor on students' academic achievement in chemistry when taught using MMTS. Furthermore, the results revealed a significant interaction effect of gender and treatment on achievement. The study recommended that Chemistry teachers should adopt MMTS as a teaching strategy in chemistry classrooms and laboratories. Workshops and seminars should be organized for in-service chemistry teachers. The teacher training institutions should include the use of MMTS in their chemistry method course content to ensure the training of the pre-service chemistry teachers.*

**Keywords:** Gender, Mean Achievement Score, Chemistry Students, Mend Mapping Teaching Strategies.

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## **Introduction**

The important of science and technology on the overall development of any nation is acknowledged worldwide. The importance of science is anchored on chemistry as one of the core basic sciences for scientific and technological development.

Chemistry as a course is one of the basic requirements for some technological courses everywhere. That may be why Okeke (2005) reported that chemistry is undoubtedly described as one of the pivot subjects for technological development. These descriptions and assertions indicate the significant position accorded to chemistry as a veritable tool for sustainable science and technological development. Chemistry has contributed immensely to the betterment of the human condition in engineering plastics, plant, antibiotics, portable energy, cooking, cleaning, medicine, drug and environmental issues ([www.unilorin.edu.ng/ejournal](http://www.unilorin.edu.ng/ejournal)).

In Nigeria achievement in Science basically in Chemistry has continued to be poor due to the poor input in terms of academics, and this has also led to a poor trend of students' performance in chemistry examinations. The major stakeholders of chemistry education are worried about the development. In view of the noted development in students' trends of poor performance in chemistry, there is need to try some other teaching methods. The situation therefore calls for exploration of other teaching methods found effective in some other fields and countries (Ezeudu, 1991; Nast, 2006; Buzan and Buzan, 2006).

Opara (1997) proposed that teachers should use teaching strategies that are constructive in nature and which should involve learners' active participation and promote skill acquisition. Such strategies should be able to generate interest among students in the learning process. Thus mend mapping teaching strategy was suggested due to its efficacy in other fields.

Buzan (1991) stated that mend mapping teaching strategy (MMTS) is a constructive and classification graphic organizer of ideas which uses the cortical skills to unlock the brain potentials. Buzan and Buzan (2006) stated that a mend map is a powerful graphic organizer of ideas, which provides a universal key to unlock the potential of the individual brain. It harnesses the full range of cortical skills, words, image, number, logic, rhythm, colour and spatial awareness in a single uniquely powerful manner. In doing so it gives the learner the freedom to

roam the infinite expanses of his or her brain. Thus this study seeks to explore the effect of MMTS on the mean achievement score of both male and female chemistry students.

### **Statement of the Problem**

Despite all the importance of chemistry as a key science subject, results revealed that poor achievements have consistently been reported in Nigerian external examinations (West African Examination Council, WAEC, 2001 – 2010) and the Chief examiner report of (NECO, 2006). Chemistry being one of the basic science subjects in which students perform very poorly may be due to many factors – such as mathematical aspects of chemistry, poor teaching methods and strategies, student's negative disposition and lack of interest in the subject. Many studies have been conducted in the area of gender related difference in academic achievement, in secondary school chemistry. It has been noted that males perform better than females. Other studies reported female superiority in chemistry achievement. No gender differences in students' academic achievement in chemistry have also been reported. These contradictory evidences in academic achievement, in chemistry have resulted in the need to verify the effect of MMTS and gender influence on the dependent variables of this study.

### **Objectives of the Study**

Specifically, this study seeks to:

- i. Investigate the difference in mean achievement score of students taught using MMTS and those taught without it
- ii. Ascertain the difference that exists in mean achievement score of male and female students taught using MMTS.
- iii. Determine the interaction effect of gender and treatment on mean achievement score of students taught using MMTS and those taught without it.



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## **Literature Review**

### **Conceptual Framework**

#### **Definition and nature of mapping**

A mind map is a diagram used to represent words, ideas, tasks or other items linked to and arranged radial around a central key word or idea (Buzan, 1991). (Buzan and Vanda, 2005) reported that mind map is needed to generate, visualize, structure and classify ideas, and as an aid in study, organization, problem solving, decision making and writing. It is an image-centered diagram of information. Mind map presents the connections in a radial, non-linear graphical manner. Hence it encourages brainstorming approach to any given intrinsically appropriate role for theoretical or conceptual framework to work with. To create your first mind map you will need a large white plain sheet of paper and some colored pens. A mind map uses 4 key characteristics to form 1<sup>st</sup>, Central image of the subjects' topic is formed 2<sup>nd</sup>, main themes radiate from the central image. 3<sup>rd</sup>, Branches hold the key words on the central image. 4<sup>th</sup>, Smaller branches form a connected structure from main branches.

Once you have tried your first mind map take another topic or even prepare a mind map about yourself, your hobbies, interests, where you live, what key things you did last year etc. Practicing as much as possible will help you become more familiar with the mind mapping process. A mind map is based on radial or star structures. Hermann and Bovo (2005) stated that people have been using image-centered radial graphic organization techniques referred to as mental or generic mind maps for centuries in areas such as engineering, psychology and education although the claim to the origin of mind map has been made by a British popular psychologist and author (Buzan, 1991). The mind map continues to be used in various forms and for various applications including learning in education (whereas it is often taught as webbing). Planning and in engineering diagramming. Buzan (2001) suggested that mind maps have many applications in personal family, educational business situations, including note taking, brainstorming where in ideas are inserted into the map radial around the central node, without the implication or sequential arrangement, and where in grouping and organizing is reversed for later stages, summarizing, revising and general clarifying of thought. Buzan and Vanda (2005) further

suggested that one could listen to a lecture and take down notes using mend map for the most important points or key words. A mend map is similar to a road map to help you on your journey. It provides an overview or picture of a particular subject and helps you plan your route or choices. The mend map stores large amount of information efficiently, but the exciting part of form is discovering that the final mend map is not only easy to read and look at, but also uses the potential of the brain in a very exciting way. It helps develop new brain skills, which are overlooked by traditional teaching method (Buzan, 2001).

Similarly Okwo (2002) stated that the activity mode of pictures, drawings and photographs facilitates instructions and mind map encompasses the above activities and similarly facilitates instructions. Buzan and Vanda (2005) state that one of the main reasons why mend mapping is so effective is how it enhances the acquisition of scientific skills, technological skills and even entrepreneurial skills within our brain, one can also use mind maps as a mnemonic techniques or to sort out a complicated idea. Mend maps are promoted as a way to collaborate in colour or pen creativity sessions. The researcher therefore suggested that mend maps can be drawn by hand, either as “rough note” for example, during a lesson or taking minutes of meeting.

Williams (2000) declared in his encyclopedia that software and techniques research have concluded that managers and students find the techniques of mend mapping to be useful, being better able to retain information and ideas than by using traditional “linear” note taking (lecture) method. Buzan and Buzan (2006) suggested using the following foundation structures for mend mapping guidelines. The guidelines are stated in steps as shown. First, start in the centre of a piece or plain paper or cardboard with an image of the topic using at least 3 colours. Second, use images, symbols, codes and dimensions throughout your mend mapping.

Third, select key word and print using upper or lower case letters. Fourth, each word or image must be alone and sitting on its own line. Fifth, the lines are connected starting from the central image. Sixth the central lines are thicker, organic and flowing becoming thinner as key radiate out from the centre. Seventh, make the lines same length as the word/image. Use colours you code throughout the mend map. Eighth, develop your own style of mend mapping. Ninth, use emphasis and show association in your mend map. Tenth, keep the mend map clear by using radial hierarchy, numerical order or outlines to embrace your branches (Buzan, 2001). Buzan

(2001) also hypothesized that the mind utilizes the full range of left and right cortical skills, balances the brain, taps into the alleged 99% of your used mental, as well intuition which he called “Super logic”. However, scholarly research suggested that such may actually be a marketing hype based on misconception about the brain and the cerebral hemispheres. Hemispheric specialization theory has been identified as pseudo-scientific when applied to mind mapping and concept mapping (Williams, 2000). He argued that there are benefits to be gained by applying a wide range of graphic organizers, and it follows that mind mapping specifically, is not equally suited to all learning tasks. Buzan and Buzan (2006) stated that the mind mapping laws are designed to help you more rapidly gain access to your intelligence by giving you specific techniques that are brain-compatible. By following the laws, your memory and creativity will be enormously enhanced.

### **Origin of mind mapping**

Mind mapping concept was developed in the 70’s by Tony Buzan. It all started when he was 7 years old. Buzan was puzzled by the differences in ability of his classmates and after many years of research, questioning and exploring, he developed mind mapping which he called “Use your head”. This mind mapping book was produced as television series and a book with BBC (British Broadcasting Cooperation) in 1974. He has since developed powerful graphic techniques which are used by individuals worldwide in schools, universities and business. His mind map work has since been published over 100 countries and in 30 languages in his quest for helping millions of people to use their brain more effectively to improve memory, reading skills and become genius in their own way. He has also developed numerous mind mapping software’s. In the year 2000, Tony Buzan described the start of the new century as the “millennium of the mind and the century of the brain”. Buzan T is now world authority on the brain, memory, creativity and speed reading.

### **Mind mapping Laws**

**Law one.** A mind map commences in the center of a page within a multi-coloured image or symbol.

Reasons: it commences in the center because this reflects the many-hooked nature of the brain's thinking process, and allows more space and freedom for developing ideas from the central core. Use image and colour because the old adage, "a picture is worth a thousand words" applies here in both memory and creativity.

**Law Two.** Main themes are attached to the central image on main lines using large capital letters.

Reasons: Main themes are attached because the brain works by association and if the lines are attached, the ideas will internally be similarly "attached". The lines are thicker and the printing larger to reflect the importance of these ideas.

**Law Three.** Lines are connected to lines.

Reasons: The connected structure of the mend map reflects the associative nature of the brain.

**Law Four:** Word are printed.

Reasons: Printing the words on the line gives them connection and association to the basic structure of the mend map. People often find that if they can reconstruct the general skeleton of the mend map, the words immediately "Pop in" to place.

**Law Five:** Single key word per line is allowed.

Reasons: Each key has its own million ranged of possibilities for association. Placing the key word alone on a line gives the brain more freedom to branch out from that word. Phrases trap the individual word, and reduce the possibilities for creativity and the clarity of memory.

**Law Six:** Use of colour throughout the mend map.

Reason: Colour is a major stimulator of all forms and especially enhances creativity and memory. It also appeals to aesthetic sensitivities which increase the brain's pleasure in building the Mend Map, and its interest in returning to, reviewing and using it.

**Law Seven:** Images throughout the Mend Map must be used.

Reason: It is appropriate for brain training: “Learn the science of Art.” The use of images can raise memory performance to near perfect multiplies, creative thinking effectiveness by as much as ten times and improves problem solving and communications, etc. it also, over time, increases the individual’s perceptual capabilities and skills.

**Law Eight.** Use codes and symbols throughout the mend map.

Reasons: Personalized codes using various shapes such as colours and arrows add a “Fourth Dimension” to a Mend Map. They greatly enhance the Mend Mapping ability to analyse, define, structure, organize and reason.

Buzan and Barry (2005) suggested that the following list highlights just some of the uses of mend map. They are taking notes in meetings, generating ideas and thinking creatively, planning projects, organizing, processes, tracking progress, preparing a presentation or essay/ report, Learning/ Studying, note taking, review, recall and exam preparing, Scheduling, Analysis, Decision making, Prioritizing, clarification and preparing key documentation for reports or projects.

### **Students’ Gender and Achievement in Chemistry**

Falade (1982) carried out a study on “the construction and validation on a formative achievement test on chemical formulae for senior secondary class three chemistry students”. The researcher administered the validated instrument to the students. After data analysis of the study, he found out the sex has no significant effect on students’ performance.

In another study Joseph (1996) sampled gender differences in senior secondary school chemistry performance in Akwalbom State. Two null hypotheses guided the study. A sample of 380 SS 3 students was used in three different secondary schools for a study. The schools were selected through stratified random sampling. The instrument used was chemistry achievement test (CAT) which was administered to the students. The results revealed a significant gender difference in favour of males. This trend may be attributed to the fact that females regard science subject as intellectually complex and task oriented.

Ifeakor (2005) evaluated the effects of commercially produced computer assisted instruction package (CPCAIP) on students' achievement and interest in chemistry. The study also sought the effect of CPCAIP and gender on students' academic achievement and interest in chemistry. The performance of students taught with CPCAIP was compared with those of students taught with conventional teaching method (CTM). Six research questions and six hypotheses guided the study. The design of the study is the pre-test-post-test quasi experimental non randomized control group type involving 4 intact classes. The sample size was 140 SS I chemistry students from two private secondary schools drawn randomly using balloting from 31 private secondary schools in Onitsha North and South Local Government Area of Anambra State. Two instruments chemistry achievement test (CAT) and chemistry interest inventory (CII) were developed, validated and used for trial testing and collecting data. The data obtained were analysed using mean and standard deviation to answer researcher questions while hypotheses were tested at 0.05 level of significance using ANCOVA f-statistics. The result of the analysis indicated among others that gender was a significant factor in the students overall cognitive achievement in chemistry in favour of males.

Falade (1982) carried out a study on the construction and validation of a formation achievement test on chemical formula in chemistry for senior secondary three chemistry students the study was aimed at determining the effect of sex on students' achievement in chemistry. Two instruments chemistry achievement test (CAT) and chemistry interest inventory (CII) were developed, validated and used for trial testing and collection of data. The result indicated that sex was a significant factor in the overall cognitive academic achievement in favour of males.

The researcher has reported that chemistry students in secondary school performed poorly over the years (WAEC, 2001-2010). Some other studies have been conducted in the area of gender and academic achievement in chemistry. Research findings on academic achievement due to gender are contradictory. Some of the studies revealed significant gender-related differences in students' cognitive achievement in chemistry. In general, there are three categories of results from studies on gender-related differences in science achievement that are available. The first category is that in which there is significant gender difference in chemistry achievement score in favour of boys. The second category is that in which there is significant difference in chemistry

achievement score in favour of the girls. The third group is that in which no gender difference in chemistry achievement score is neither detected in favour of the boys nor the girls. Studies reviewed above do not seem to provide a clear picture of gender differences in achievement scores in gender. Indeed, the review of literature conducted in this section indicated an inconclusive and inconsistent trend in gender difference in the sciences and chemistry in particular. In view of the noted inconsistency, there is need to evaluate this issue of gender and its related differences in achievement using an innovative teaching strategy mend mapping teaching strategy (MMTS).

## Research Methodology

### Research Design

This study adopted quasi experimental non-equivalent pretest-posttest non randomized control group design. Intact classes were then used for the study. Subjects were not randomly assigned to groups rather intact classes were assigned to experimental and control groups.

The design way symbolically represented below

**Table 1: Design.**

Design	Achievement
Experimental group (MMTS)	O <sub>1</sub> X O <sub>2</sub>
Control group (CTM)	O <sub>1</sub> C O <sub>2</sub>

X = Treatment using MMTS (experimental)

C = CTM (control)

O<sub>1</sub> = Pre-test of CAT

O<sub>2</sub> = Post-test of CAT

## Population of the Study

All the senior secondary two chemistry students in Enugu Education Zone made up the population. The figure was 4,698 as indicated in the Post Primary School Management Board (PPSMB) statistical unit of Enugu Education Zone, 1<sup>st</sup> term 2008/2009 academic session. They were 23 state secondary schools in all made up of 11 single sex (4 males and 7 females) schools and 12 co-educational schools.

## Sample and sampling technique

The sample of this study is 194 SS2 chemistry students (95 boys and 99 girls) in the four sampled schools. The students offered chemistry as one of their SS2 subjects. The sampling technique was multi-stage sampling. 1<sup>st</sup>, 2 LGA out of 3 in the Education zone were sampled out by random sampling (balloting). 2<sup>nd</sup>, 11 single sex schools were purposively sampled of chemistry classes and gender is an independent variable of this study. 3<sup>rd</sup>, the single sex schools were stratified. Out of 4 male schools 2 were sampled and out of 7 female schools 2 were sampled by random sampling (balloting). 4<sup>th</sup>, out of the two streams from each school one class were assigned treatment (MMTS) and the other control (CTM) by random sampling (toss of coin). The distribution of the research subjects in their intact classes of this study is shown in Table 2 below.

**Table 2: Distribution of Subjects in their Various Intact Classes in the School of Study by Gender**

S/N	SCHOOLS	GENDER	MMTS (EXPERIMENTAL GROUP)	CTM (CONTROL GROUP)	TOTAL
1.	Girls Sec. Sch. Abakpa Nike Enugu	Girls	24	25	49
2.	Girls Sec. Sch. Emene Enugu	Girls	26	24	50
3.	Nike Grammar Sch. Enugu	Boys	25	23	48
4.	St. Patrick's Sec. Sch. Emene Enugu	Boys	23	24	47
	<b>TOTAL</b>		98	96	194

## Instrument for Data Collection

The instrument developed by the study for data collection is the chemistry achievement test (CAT). The chemistry achievement test (CAT) was for collection of pre-test achievement score, post-test achievement score.

## Development of Instrument

The CAT is made up two sections, Section A and Section B. Section A contains personal data. Section B contains instructions for answering the questions and the items. The CAT is a 40 item, 4 options multiple choice objective test based on the content of the study in SS2 chemistry curriculum as shown in table 3 below. The table contains specification used in selecting the items. The instrument contains four options 2 A-D for each of the 40 items selected out of the initial pool of 50 items. After validation, ten items were declared invalid by the experts. The table of specification below has 5 subunits of content of the study which was subdivided from 3 main units as specified earlier (FME, 1985)

**Table 3: Table of Specification for Chemistry Achievement Test (CAT)**

Content	Lower order	Higher order Objectives 40%	Total 100%
Rate of chemical reactions and factors affecting the 20%	5	3	8
Energy changes in chemical reactions 20%	5	3	8
Endothermic and exothermic reactions 20%	5	3	8
Equilibrium in chemical reactions 20%	5	3	8
Free energy changes, enthalpy and entropy changes in chemical reaction 20%	5	3	8
<b>100%</b>	<b>25</b>	<b>15</b>	<b>40</b>

The number of weeks each topic lasted in the Post Primary School Management Board (PPSMB) common scheme of work of secondary schools formed the basis of the weighting of the contents.

The weighting for the objectives level was based on the proportion of lower and higher order performance objectives in the units of the study.

### **Face Validation of Instruments**

The CAT was face validated by two senior academic staff in Measurement and Evaluation and two in Chemistry Education from the University of Nigeria, Nsukka.

### **Content Validation of Instruments**

To ensure content validity of the CAT, a table of specification for chemistry achievement test (CAT) was developed and it was validated by the experts with specification of curriculum developers. Two senior academic staff each in Measure and Evaluation and in Chemistry Education of the University of Nigeria, Nsukka validated the CAT items.

### **Trial testing of Instruments**

The CAT instrument was trial tested using forty (40) SS2 chemistry students of the College of Immaculate Conception (CIC) and 40 students of the Holy Rosary College in Enugu. The CAT was administered to 40 students of the schools by their Chemistry teachers. An hour was allowed for the test. The papers were marked, scores collated and collected. The choice of the above schools for the pilot testing was because these schools were considered equivalent to the schools of the study proper.

### **Reliability of the Instruments**

The student's responses in the CAT were used to calculate the reliability coefficient of the CAT using Kuder Richardson's formula 20 (K-R20) procedures. The reliability coefficients for the CAT was 0.8359.

### **Method of data collection**

The pre-test score, post-test scores were recorded after each marking exercise. The CAT items scored 2 marks each. The maximum mark is 80 marks for pre-test, and post-test scores respectively. A total of 194 copies of the CAT were issued and retrieved.



## Methods of data analysis

The two research questions were answered using mean and standard deviation scores while the three null hypotheses were tested at 0.05 alpha level of significance using analysis of covariance (ANCOVA). The pre-test scores were used as covariates to the post-test scores. ANCOVA was appropriate here because it served as a procedure for controlling the initial groups' differences as well as increasing the precision due to the extraneous variables thus reducing error variance (Ferguson, 1981).

## Decision rule

Reject the null hypothesis if the calculated value of test statistics F-Cal is equal to or greater than the critical or table value ( $F - Cal \geq F \text{ critical}$ ) at 0.05 level of significance, and appropriate difference, otherwise accept.

## Data Presentation, Analysis and Results

### Research Question 1

What is the difference in mean achievement score of students taught using mend mapping teaching strategy (MMTS) and those taught without it?

**Table 4: Mean (X) and Standard deviation (SD) of achievement Scores of subjects by gender (MMTS and CTM).**

Method	Gender				Overall	
	Male		Female			
MMTS (experimental) N	X	SD	X	SD	X	SD
	18.17	8.93	25.74	7.33	21.95	8.13
	48		50		98	
CTM (control) N	8.32	3.19	10.12	1.76	9.22	2.48
	47		49		96	
Overall N	13.24	6.06	17.93	4.55	15.58	5.30
	95		99		194	

As shown in Table 4 above, mean achievement score of students taught using MMTS is  $X = 21.95$  while mean achievement score of students taught using CTM is  $X = 9.22$ . The difference in mean achievement score of students taught using MMTS and those taught using CTM is 12.23 in favour of MMTS groups. This suggests that students taught using MMTS obtained higher academic achievement score than students taught using CTM. Similarly students taught using MMTS obtained standard deviation score of 8.13 while students taught using CTM obtained standard deviation score of 2.48. This is an indication that students taught using MMTS obtained higher lower spread out of scores about their mean than students taught using CTM that obtained lower spread out of scores about their mean. In order to make a valid decision on whether the students' difference in mean achievement score based on the use of MMTS and CTM in teaching senior secondary chemistry was due to error or variance, null hypothesis 1 was tested.

### Hypothesis 1

There is no significant difference in mean achievement score of students taught using MMTS and those taught without it.

**Table 5: Summary of analysis of covariance (ANCOVA) on subjects' Pre-CAT and Post-CAT mean achievement scores by gender (MMTS and CTM)**

Sources of variation	Sum of squares	Degree of freedom (DF)	Mean square	F-Cal	F –Critical	Decision at $P \leq 0.05$ level
Covariates	201.36	1	201.36	5.60		
Pretest	201.36	1	201.36	5.60		
Main effect	6512.11	2	3256.06	90.55		
Treatment	6023.79	1	6023.79	167.51	3.84	S
Gender	811.63	1	811.53	22.57	3.84	S
2 way interactions	504.59	1	504.59	14.03		
Treatment X Gender	504.59	1	504.59	14.03	3.84	S
Explained	9618.25	4	2404.56	66.87		
Residual	6796.41	189	35.96			
Total	16414.669	193	85.050			

**S = significant at 0.05 probability level; NS = Not Significant at 0.05 probability level.**

As shown in Table 5 above, the calculated F-ratio for MMTS (treatment) is 167.51 against the F-critical value of 3.84 at 0.05 level of significance, 1df numerator and 193df denominator. Since F-calculated value of 167.51 is greater than the F-critical of 3.84. Therefore null hypothesis 1 of

no significant difference in the mean achievement score was rejected. This implies that the observed difference in the mean achievement score of students taught using MMTS and those taught using CTM was significant and was due to variance and not attributed to error.

### **Research Question 2**

What is the difference in mean achievement score of male and female students taught using MMTS?

As shown in Table 4 above, mean achievement score of the female students taught using MMTS is  $X = 25.74$  while mean achievement score of the male students taught using same MMTS is  $X = 18.17$ . The difference in mean achievement score of male and the female students taught using MMTS is 7.57 in favour of the females. This suggests that the female students taught using same MMTS obtained higher academic achievement score than the male students taught using same MMTS. Similarly the male students taught using MMTS obtained standard deviation score of 8.93 while the female students taught using same MMTS obtained standard deviation score of 7.33. This is an indication that the male students obtained higher spread out of scores about their mean than the female students who obtained lower spread out of scores about their mean. In order to make a valid decision on whether the students gender difference in mean achievement score based on the use of MMTS in teaching senior secondary chemistry was due to error or variance, hypothesis 2 was tested.

### **Hypothesis 2**

Gender does not significantly influence the mean achievement score of students taught using MMTS.

As shown in Table 5 above, the calculate F-ratio of gender influence on mean achievement score of students taught using MMTS is 22.57 against the F-critical value of 3.84 at 0.05 level of significance, 1df numerator and 193df denominator. Since F-calculated value for gender influence on mean achievement score of 22.57 is greater than F-critical of 3.84. Null hypothesis 2 of no significant gender influence on mean achievement score of students taught using MMTS was rejected. This implies that the observed influence on mean achievement score of students taught using MMTS was significant and was due to variance and not attributed to error.

### **Hypothesis 3**

The interaction effect of gender and treatment on mean achievement score of students taught using MMTS and those taught without it is not significant.

As shown in Table 5 above, the calculated F-ratio for interaction effect of gender and treatment on mean achievement score is 14.03 against the F-critical value of 3.84 at 0.05 level of significance, 1df numerator and 193 denominator. Since F-calculated of 14.03 is greater than F-critical of 3.84. Null hypothesis 3 of no significant interaction effect of gender and treatment on mean achievement score of students taught was rejected. This implies that the observed interaction effect of gender and treatment on mean achievement score of students taught using MMTS and CTM was significant. It was due to variance and not attributed to error.

### **Summary of Result**

The major findings in this report are shown below.

1. Mean achievement score of students taught using MMTS was significantly higher than those taught without it.
2. Gender influenced mean achievement score of students taught using MMTS significantly.
3. Significant interaction effect of gender and treatment on mean achievement score of students taught using MMTS and those taught without it was observed.

### **Conclusion**

This study has shown that the MMTS has significant effect on students' cognitive achievement, in Chemistry. The MMTS is more efficacious than the CTM. The influence of gender on mean achievement score was significant.

### **Recommendations**

Since MMTS is found to be an effective teaching strategy for improving students mean achievement score in chemistry. Chemistry teachers should adopt it as a teaching strategy in chemistry classrooms and laboratories. Workshops and seminars should be organized for in-service chemistry teachers. The teacher training institutions should include the use of MMTS in their chemistry method course content to ensure the training of the pre-service chemistry teachers.

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