# INFLUENCE OF GUIDED DISCOVERY AND PROBLEM SOLVING STRATEGIES ON ACADEMIC ACHIEVEMENTS AND RETENTION OF MALE AND FEMALE STUDENTS IN VOLUMETRIC ANALYSIS IN MINNA METROPOLIS.

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**Abstract**
*This study investigated effects of guided discovery and problem solving on achievement and retention of secondary school Chemistry students' on Volumetric analysis based on gender in Minna Metropolis, Niger State. Four hypotheses were formulated and tested at 0.05 alpha level of significance. A 3 x 2 x2 factorial design was adopted for this study. The population consisted of 238 (116 female and 122 male) selected from six schools in Minna Metropolis. The research instrument employed was a 23-item Chemistry Achievement Test (CAT) developed on Volumetric Analysis and was validated by experts in Chemistry. A reliability coefficient of 0.88 was obtained using Kuder Rechardson (K-$R_{21}$). Students were pretested before the treatment began, after the treatment CAT was administered as posttest, then CAT was reshuffled and administered after two week of posttest as post-post test. The data obtained from both pretest, posttest and post- posttest were analyzed using Analysis of covariance(ANCOVA) with Statistical Package for Social Sciences (SPSS) version 20.0. The hypotheses on achievement was not significant but at retention level guided discovery was significant in favour of male while that of problem solving is not significant. Therefore problem solving and guided discovery is recommended for Chemistry teachers which enhance achievement The results shown both male and female student benefited from guided discovery and problem solving at achievement level Thus, it is recommended that teachers should expose both male and female Chemistry students to guided discovery and problem solving instructional strategies that promote and encourage social interaction, active learning and ultimately enhance achievement and retention. The stakeholders in education sectors should also encourage and enforce the use of guided discovery and problem solving instructional strategies in teaching and learning of Chemistry in particular and sciences in general in our secondary schools.*

**Keywords:** Guided Discovery, Problem Solving, Achievement, Retention, Gender, Volumetric Analysis.

## Introduction

Problem solving can be defined as whatever action a person takes to bridge the gap between the anticipated solution and the problem itself. Problem solving ability is the ability to bridge the gap between a problem and a solution by using information (knowledge) and reasoning.Chemical problem-solving as a process involves bridging the gap between a problem and a situation using chemical knowledge (Ajaja,2009). This shows that problem-solving in Chemistry requires the prerequisite knowledge to reason through the problem in order to arrive at the solution (Orimogunje, Oloruntegbe, Oke & Gazi, 2010).

Guided discovery is one of those teaching methods that employ exploration, manipulation and experimentation to find out new ideas, it is a problem solving oriented strategies (Akuma, 2008). Guided discovery instructional strategy, is characterized by convergent thinking,the instructor devises a series of statements or questions that guide the learner, step by step logical, making series of discoveries that lead to a single predetermined goal. In other words, the teacher initiates

a stimulus and the learner reacts by engaging inactive inquiry thereby discovering the appropriate response.
The guided discovery method is a student-centred, activity-oriented teaching method in which the teacher guides the students through problem-solving approach to discover answers to the questions. This method lends itself meaningfully to integration of theory and practical works, and each activity is followed by a discussion.Most studies in recent years have investigated topics in secondary school curriculum which pose learning quantitative problem-solving (Clarke and Rutherford, 2000 & Schmidt, 2000).

Research results have shown that the students learn meaningfully when they work in small groups, have the opportunity to negotiate meaning and construct conceptual understanding in community of learners (Agbi, 2006). This is in agreement with a Chinese proverb that says "What I hear, I forget, what I see, I remember, what I do, I understand".The students' ability to achieve within the classroom setting has been largely adduced to the quality of instruction, personality of the teacher and availability of instructional materials among other factors. Sabiru (2014) has used this instructional method in Katsina state on the topic balancing of chemical equation which proven that it improves the achievement of students in Chemistry.Nwachukwu (2013) viewed achievementbasically as the competence a person has in an area of content. This competence is the result of many intellectual and nonintellectual variables. It is a word preferred in the educational or psychometrics fields being characterized by the degree of inference required on the part of the student to give a response, and by the type of reference to a cognitive process made explicit in the measurement tool. Achievement in volumetric analysis mean ability to score50% of the total allocated for this aspect of Chemistry (volumetric analysis)

Volumetric analysis is a technique that employs the measurement of volumes to determine quantitatively the amount of a substance in solution. In any reaction between two ormore species, the reaction equation will show the stoichiometric ratio of reacting species. Ability to use volumetric analysis to determine the amount of substance used is called titration. There are three types of titration and these are direct titration, indirect titration and back titration. Volumetric analysis is so important that it carries higher percentage mark in any standard examination such as West African Examination Council(WAEC), National Examination Council (NECO).According to WAEC and NECO Chief Examiner's Reports between 2011 and 2014, students failed this aspect of Chemistry examinations, which leads to low achievement in the subject. This study therefore investigatesthe influence of guided discovery and problem solving strategies onacademic achievements of male and female students in Volumetric analysis in Minna Metropolis.

Gender issues currently receive the attention of researchers and remain the main focus of discussion and research all over the world, Nigeria inclusive. The question of gender is a matter of great concern especially among scholars and policy formulators. Intellectuals are worried about the role of women and men in the political, social, economic, cultural, psychological, religious, scientific and technological development of nations. Ibraheem(2001) also confirmed that "women have physical and mental capabilities to contribute meaningfully to the stability, progress and prosperity of Nigeria with their overwhelming population in this country. The Human Development Report, in its gender-related development index as reported in Azgaku (2007), placed Nigeria in the 100th position out of 130 countries in gender disparity and 108th position out of 116 countries in its gender empowerment measure. Despite the high population and great contributions of women to national development, they have always been considered inferior to men.Afonja (2002) defined gender as a socially constructed concept based on the assumed power and position that group of humans should possess.

In Africa, especially Nigeria, researches conducted by (Olasehinde and Olatoye, 2014:

Abdulraheem, 2012) have shown that women's participation and achievement in Chemistry are very low owing to some avoidable reasons. According to Okafor (2001), health problems such as high rate of maternal and infant mortality, malnutrition and stressful conditions which are associated with developing countries like Nigeria correlate positively with the low level of women's achievement in Chemistry. Plummer (2000) and Arnot (2003) noted that ethnicity, social class and religion are other factors that combine and interact with gender to have a direct bearing on achievement of women in Chemistry. In support of the above idea, Archer and Yamashita (2003) confirmed that gender inequalities are interwoven with social class, ethnicity, sexuality, disability and religion.

Many researchers have come out with constructive results on the causes of women's poor academic achievement in secondary schools. For example, Nwachukwu (2013) asserts that the problems that have hampered educational production especially in Nigeria over the years are lack of human and material resources.Generally, the major problems affecting the school system in Nigeria are poor management and control of teacher education programs, teacher training and re-training, selection and organization of curriculum content, curriculum implementation and evaluation, the development, distribution and use of teaching materials, and relevance of curriculum to the needs of society and method of passing instruction while teaching.

Njoku (2001) confirmed that researches indicated that girls believe that Chemistry is too difficult and not important for their future. The research explained that the teaching methods used do not assist girls to understand Chemistry. Njoku (2001) reported further that Chemistry teachers' pay more attention to boys than girls. The report also observed that there are more male Chemistry teachers and professionals than female role models in Chemistry. The under-representation of women in Chemistry manpower pool may likely be a reflection of low participation and under-achievement of girls in Chemistry in schools. Popoola (2002) agreed that girls are very good in English spellings, writing and Arts, but Chemistry,Physics, and Mathematics are masculine. Alonge (1989) therefore, called for special privileges to encourage girls to venture into Chemistry. Adesoji and Fisuyi (2001) also found out that 63% of the girls could not attempt solution to problems based on volumetric analyses. Based on this, they arrived at the conclusion that boys are better problem-solvers. Gender inequality is also reflected in enrolment into Chemistry and admission to higherinstitutions of learning.All the above mentioned factors contribute to the low level of achievement of women in education (Chemistry in particular), and the privileges given to male students assist them to become better achievers in life. This above reason informed the researcher to find it very imperative to look for student's centered strategies that will challenge students' thinking such as guided discovery and problem solving strategies in order to find lasting solution to the ugly situation of Chemistry phobia.

**Statement of the Problem**

Despite the fact that women constitute almost 54% of Nigerian population, the incidence of gender disparity against women is increasing and alarming most especially in Volumetric Analysis.Volumetric analysis is an aspect of Chemistry that is evaluated as Practical Chemistry Paper 1 at external examinations such as West African Examinations Council (WAEC) and National Examinations Council (NECO) which carries the lion share of total mark of the whole evaluation.It has been observed that poor academic performance of girls in this aspect of chemistry (volumetric analysis) in Nigerian secondary schools has to do with method of instruction that is not gender friendly (Chief Examiner Report, 2013-2014). This study therefore employs the methods that are gender friendly (guided discovery and problem solving) to investigatedifference in male and female students'achievement and retention of secondary school Chemistry students in volumetric analysis in Minna Metropolis, Niger State.

**Purpose of the Study**

The purpose of this study was to investigate the effects of guided discovery and problem

solvingon achievement and retention of secondary school Chemistry students in Volumetric Analysis in Minna Metropolis, Niger State.
The following specific objectives we reachieved:

(i) Investigated of the effect of gender on achievement of students taught Chemistry using guided discovery strategy.
(ii) Determined the influence of gender on the achievement of secondary school students taught Chemistry using problem solving strategy.
(iii) Finding out the effect of gender on retention of Chemistry students taught with guided discovery.
(iv) Determined the influence of gender on retention of Chemistry students taught with problem solving.

**Research Questions**

This work seeks to answer some research questions related to the objectives of the work. The research questions are as follows:

(1) What is the effect of gender on academic achievement of secondary school students taught Chemistry using guided discovery strategy?
(2) What is the influence of gender on achievement of secondary school students taught Chemistry using problem solving strategy?
(3) What is the influence of gender on retention of secondary students taught Chemistry using guided discovery?
(4) What is the influence of gender on retention of secondary school students taught Chemistry using problem solving?

**Hypotheses**

The following null hypotheses were formulated and tested at 0.05 alpha level for their level of significance in order to answer the above research questions.

**$H0_1$:**There is no significant difference in the academic achievement of male and female secondary school students taught Chemistry using guided discovery.
**$H0_2$:** There is no significant difference in the academic achievement of male and female secondary school students taught Chemistry using problem solving.
**$H0_3$:** There is no significant difference in the retention score of male and female students taught Chemistry using guided discovery.
**$H0_4$:** There is no significant difference in the retention score of male and female students taught Chemistry using problem solving.

**Methodology**

The design adopted for this study is an quasi- experimental design. It is a pretest, posttest, non-equivalent, control group (Fraenkel and Wallen, 2008). A $2^3$ single treatment factorial design was employed.

The sample for this study consisted of 238(116 female and 122 male) students selected from six secondary co-educational schools in Minna Metropolis, Niger State. These schools are Bosso Secondary School, Day Senior Secondary School, Maikunkele B, Day Secondary School Chanchaga A, Day Secondary School Limawa, UBE Tundun Fulani and Zarumai Model School, Minna. Based on the nature of this research, a four-stage sampling technique was adopted. Firstly, a purposive random sampling technique was adopted to obtain six secondary schools in Minna Metropolis. These schools were purposively sampled based on equivalence (laboratories, facilities and manpower), school type (public school), and candidates' enrolment (enrolling students for SSSCE Chemistry Examinations for minimum of ten years).

Secondly, the selected six equivalent co-educational schools were assigned to each of the two experimental groups and control group through balloting. Four schools were assigned into experimental group, that is, two into Guided Discovery and remaining two and the remaining into Problem Solving.

Finally, Stratified sampling technique was used in selecting sample size for this study. By implication, the researcher arranged the list of element in the school into different strata based on gender (male and female).

The research instrument that was used for this study was a 23 – item Chemistry Achievement Test (CAT). The CAT consisted of twenty-three (23) objective items developed on the concepts that was taught, and it was used to obtain data on students' gender, achievement and retention after the treatments and the same was used for pilot study to determine the reliability of the instrument.

The CAT was designed to measure the six levels of cognitive domains of the students. The number of items measuring each domain level is as shown in Table 1. The necessary procedure for test development, that is, preparation of chart of specification, item construction, content validation, try out for item analysis and revision was followed. The CAT consisted of items with five optional answers A – E (one correct and four distracters) as possible answers to each question raised.

The students were required to indicate the correct answer(s) by ticking or circling the right letter from options A – E. The test is in two sections and the students are expected to respond to both,viz:Section A (Biodata Section) which is designed to obtain information on students' school, class, gender, age, subject and date on which test is administered; and Section B which elicits information on the students' cognitive level based on learned materials (Table 1). The questions and the accompanying answers were validated by the experts in the subject area. A reliability test was also carried out for the instrument using Kuder Richardson ($K\text{-}R_{21}$), which reveals a reliability of 0.88 and this value was considered very adequate for research study.

The students in guided discovery and problem solving groups were instructed by the trained teachers using the appropriate teaching strategies mapped out for each group. Both groups were taught using lesson plans designed using guided discovery and problem solving methodologies. These instructional strategies outline the typical steps a student goes through in the scientific solution of a problem. The two versions of the lesson plans drawn from the volumetric analysis were prepared and validated. However, the Chemistry teachers of sampled schools were trained as research assistants for a period of one week on the implementation of the methodologies used for the treatment groups under the supervision of the researcher in order to control teacher – effect factor, and the instructions to students in all schools proceeded thereafter.

The CAT instrument was administered to the students at first contact with them during the firstweek of the study as pretest and the reshuffled or disguisedversion of the CAT was administered to the students in all the instructional strategy groups in the sampled schools after the sixth week of teaching as posttest. The students' scripts were collated, marked and scored.CAT questions which were reconstructed or reshuffled, that is, questions 1 – 10 become 21 – 30and 11 – 20become 1 – 10.Similarly, options A – Eare inverted, and options become E – A. This itemwas used to obtain data on retention ability of the students on the concepts that were taughttwo weeks after the posttest. Each question was scored one mark and later converted to percentage.

**Table 1:**
Specification for Chemistry Achievement Test (CAT).

| Content | Knowledge | Comprehension | Application | Analysis | Synthesis | Activity | **Total** |
|---|---|---|---|---|---|---|---|
| Volumetric Analysis | **4** | **2** | **5** | **4** | **4** | **4** | 23 |
| % of item | **17.4** | **8.7** | **21.4** | **17.4** | **17.4** | **17.4** | 100 |

The data obtained were analyzed statistically using inferential and descriptive statistics (Mean). Analysis of covariance (ANCOVA) statistics using Statistical Package for Social Sciences (SPSS) version 20.0 and the significance of the statistical analyses was ascertained at 0.05 alpha level of significance to test the research hypotheses.

**Results**

The results of this study are presented in this section

**Hypothesis One**

There is no significant difference in the academic achievement of male and female secondary school students taught Chemistry using guided discovery.

This hypothesis was tested using descriptive statistics (mean and standard deviation) and analysis of covariance (ANCOVA). The pretest mean scores of both genders were used as covariate for the analysis. The result of the analysis is as shown in Table below.

**Table 2:**

Mean Gain Score and Standard Deviation of Male and Female Students Taught Chemistry Using Guided Discovery

| Group | Pretest mean | Pretest Std | Posttest mean | Posttest Std | Mean Gain | Difference in Std |
|---|---|---|---|---|---|---|
| **Male** | 19.37 | 7.62 | 76.89 | 13.56 | 57.52 | 5.92 |
| **Female** | 19.42 | 7.64 | 56.72 | 12.20 | 37.30 | 4.56 |

From the Table 2, it was observed that male benefited from the treatment more than their malecounterparts. This is because the male students have a higher mean gain score of 57.52 with standard deviation of 5.92 while female students have a mean gain score of 37.30 with standard deviation of 4.56 and the mean difference is 5.22.

(Fig. 1). This indicates that all the groups benefited from the treatment, with male students having better posttest achievement than female students with a mean difference of 5.22

The chart below represent the male and female mean gain scores

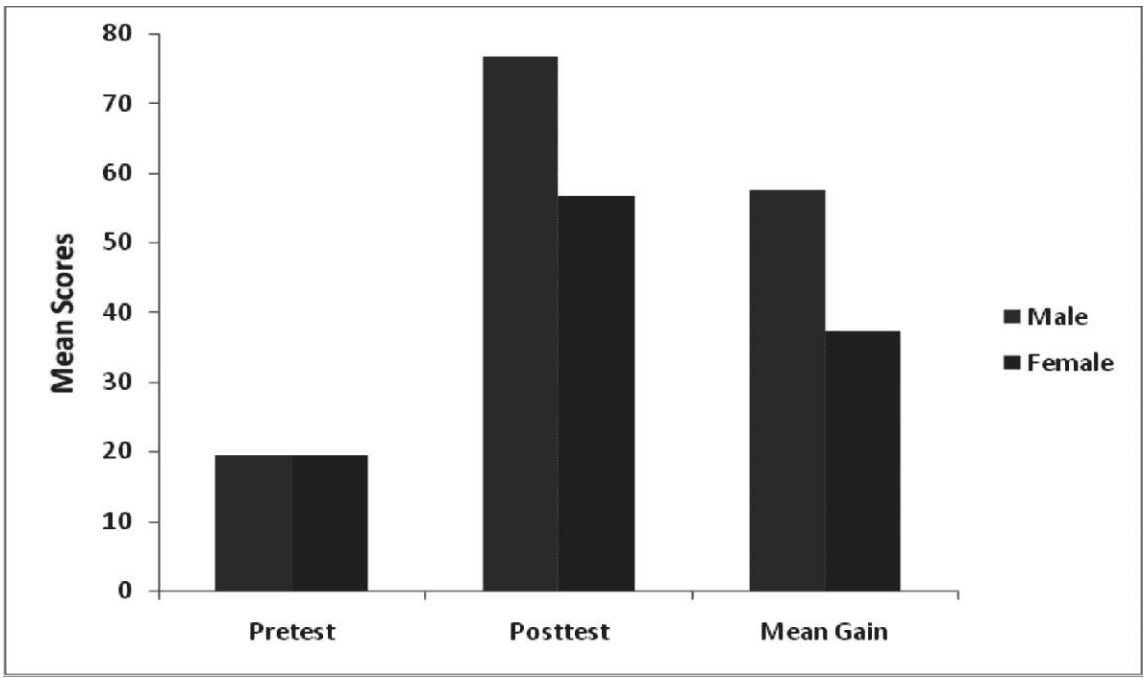


Figure 1.Multiple bar charts showing achievement gain scores of male and female students taught Chemistry using guided discovery.

**Table3:**
Analysis of Covariance of Mean Achievement Scores of Male and Female Students Taught Volumetric Analysis Using Guided Discovery

| Source | Sum of Squares | d f | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 241.194 | 2 | 120.597 | 1.668 | 0.197 |
| Intercept | 28522.131 | 1 | 28522.131 | 394.610 | 0.000 |
| Pretest | 2.476 | 1 | 2.476 | 0.034 | 0.000 |
| Gender | 241.191 | 1 | 241.191 | 3.337 | 0.073 |
| Error | 4264.483 | 59 | 72.279 | | |
| Total | 306628.000 | 62 | | | |
| Corrected Total | 4505.677 | 61 | | | |

? Not significant at 0.05 alpha level

The analysis in Table 3 indicated that an F (1, 61) = 3.34, p = 0.073, which is not less than 0.05 (i.e. p-value ˃ α-value), suggesting that the main effect was not significant at 0.05 alpha level. This indicates that there was no significant difference in the achievement of male and female students taught Chemistry using guided discovery. Therefore, this hypothesis is retained. This reveals that the male and female achievements are similar when exposed to Chemistry using guided discovery.

**Hypothesis Two**

There is no significant difference in the academic achievement of male and female secondary school students taught Chemistry using problem solving.

To find out whether any significant difference existed in the posttest of male and female students taught Chemistry using problem solving (Group 2),descriptive statistics (mean and standard deviation) and analysis of covariance (ANCOVA) was used. The results of analyses were shown below

**Table 4:**
**Mean and standard deviation taught Chemistry using problem solving**

| Groups | Pretest Mean | Pretest Std | Posttest Mean | Posttest Std | Mean Gain Score | Difference in Std |
|---|---|---|---|---|---|---|
| **Male** | 19.05 | 4.08 | 61.85 | 17.34 | 42.80 | 13.26 |
| **Female** | 14.05 | 3.34 | 52.68 | 15.65 | 38.63 | 12.31 |

From Table 4, it was observed that both male and female students benefited from the treatment. The male students, however, has higher mean gain score of 42.80 with standard deviation of 13.26 while the female students has a mean gain score of 38.63 with standard deviation of 12.31 (Fig. 2.). This indicates that both male and female students benefited from the treatment.

The chart below represent the male and female mean gain scores

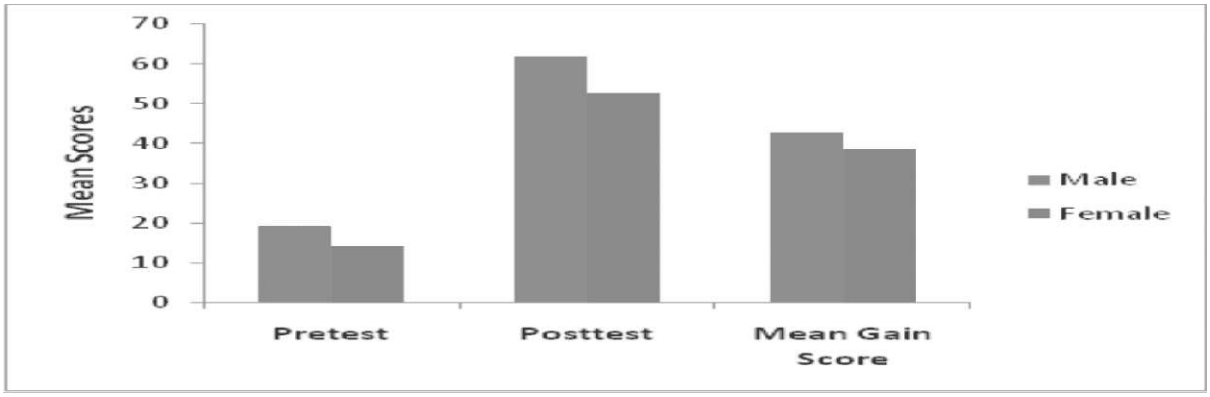


**Fig. 2:** Multiple bar charts showing retention gain scores of male and female students taught Chemistry using problem solving strategy.

**Table5:**
Analysis of Covariance of Mean Score of Male and Female Achievement Student Taught Chemistry Using Problem Solving

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 14.322 | 2 | 7.161 | 0.141 | 0.868 |
| Intercept | 24091.157 | 1 | 24091.157 | 475.593 | 0.000 |
| Pretest | 4.993 | 1 | 4.993 | 0.099 | 0.000 |
| Gender | 14.075 | 1 | 14.075 | 0.278 | 0.600 |
| Error | 4052.400 | 80 | 50.655 | | |
| Total | 278313.000 | 83 | | | |
| Corrected Total | 4066.723 | 82 | | | |

? Not significant at 0.05 level

The result of ANCOVA test as shown in Table 5 indicates that there was no significant difference in the achievement of male and female students taught Chemistry using problem solving strategies. The main effect of treatment Group 2 (problem solving) on gender produced an F (1, 82) = 0.28, p= 0.60. This result suggests that there was no significance at the 0.05 alpha level. This hypothesis is therefore not rejected but retained. This indicates that male student's achievement was not significantly different from their female counterparts when both were taught using problem solving.

**Hypothesis Three**

There is no significant difference in the retention score of male and female students taught Chemistry using guided discovery.

This hypothesis was tested using descriptive statistics (standard deviation and mean) and the analysis of covariance (ANCOVA). The pretest mean scores of both genders were used as covariate for the analysis.

**Table 6**:
Mean and Standard Deviation of Male and Female Students Taught Chemistry Using Guided Discovery

| Groups | Pretest Mean | Pretest std | Post-posttest Mean | Post-post std | Mean Gain Score | Difference in std |
|---|---|---|---|---|---|---|
| **Male** | **19.37** | **7.62** | **63.26** | **16.73** | **43.89** | **9.11** |
| **Female** | **19.46** | **7.64** | **53.34** | **13.43** | **33.92** | **5.79** |

From Table 6, it is observed that both male and female benefited from the treatment and it enhanced the retention of both groups. The male has retention scores of 43.89 with standard deviation of 9.11 and the female has the retention score of 33.92 with standard deviation of 5.79. The male students have the higher retention mean gain of 43.89 with standard deviation of 9.11 (Fig. 3.). This indicates that male students' retention ability is significantly different from that of their female counterparts when both are taught using guided discovery strategy.

Multiple bar charts showing retention gain scores of male and female students taught Chemistry using guided discovery.

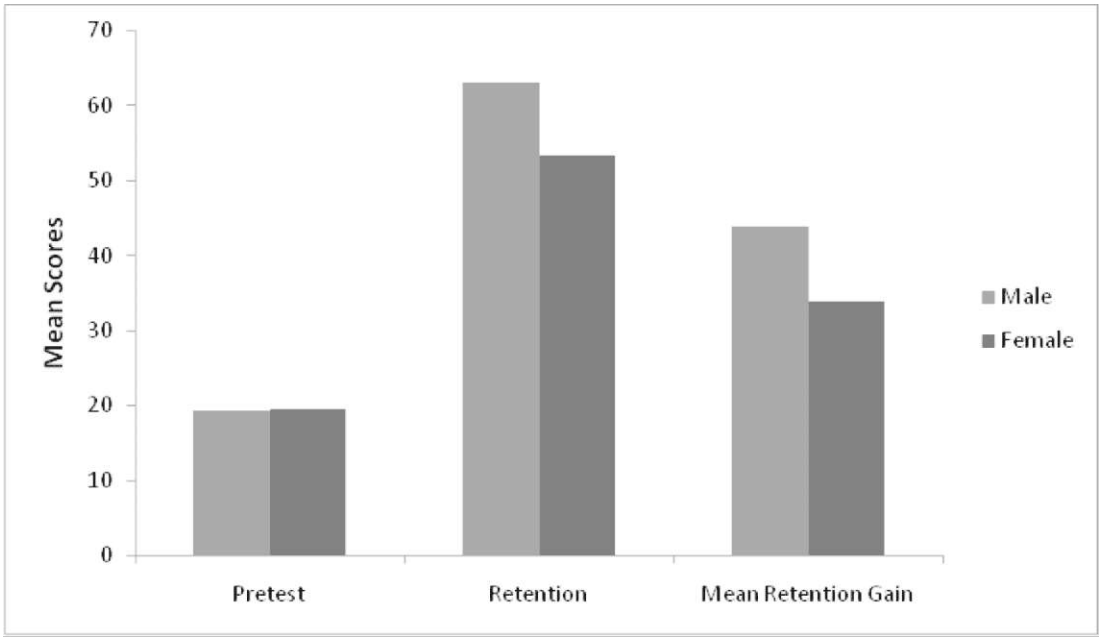


Fig. 3: Multiple bar charts showing retention gain scores of male and female students taught Chemistry using guided discovery.

**Table 7:**
Analysis of Covariance of Mean Retention Score of Male and Female Taught Chemistry Using Guided Discovery

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1093.515 | 2 | 546.757 | 8.549 | 0.001 |
| Intercept | 22694.605 | 1 | 22694.605 | 354.835 | 0.000 |
| Pretest | 14.804 | 1 | 14.804 | 0.231 | 0.000 |
| Gender | 1037.523 | 1 | 1037.523 | 16.222 | 0.000 |
| Error | 3773.534 | 59 | 63.958 | | |
| Total | 293053.000 | 62 | | | |
| Corrected Total | 4867.048 | 61 | | | |

- Not significant at 0.05 alpha level

The result of analysis in Table 7 indicates that an F (1, 61) = 16.222, p = 0.00 for groups was significant at 0.05 $\alpha$ – level. This indicates that there was a significant difference in the mean retention scores of male and female Chemistry students taught using guided discovery, therefore, hypothesis three is rejected.

**Hypothesis Four**
There is no significant difference in the retention score of male and female students taught Chemistry using problem solving. This hypothesis was tested using descriptive statistics (mean and standard deviation) and analysis of covariance (ANCOVA). The pretest mean scores of both genders were used as covariate for the analysis. The result of the ANCOVA analysis is as shown in Table 9.

**Table 8:**
Post-posttest mean and standard deviation scores of male and female students taught chemistry using problem solving.

| Groups | Pretest Mean | Pretest std | Post-posttest Mean | Post-posttest std | Post-posttest mean Gain | Difference in std |
|---|---|---|---|---|---|---|
| **Male** | 19.05 | 4.05 | 79.82 | 19.87 | 60.77 | 15.82 |
| **Female** | 14.05 | 3.34 | 68.72 | 17.65 | 54.68 | 14.31 |

From Table 8, it was observed that both male and female students benefited from the treatment. The male students have a higher post-posttest score of 60.77 with standard deviation of 15.82, while the female students have a retention score of 54.68 with standard deviation of 14.31.

**Table9:**
Analysis of Covariance of Retention Mean Scores of Male And Female Taught Chemistry Using Problem Solving.

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 168.322 | 2 | 56.161 | 0.141 | 0.660 |
| Intercept | 24091.157 | 1 | 24091.157 | 475.593 | 0.000 |
| Pretest | 4.993 | 1 | 4.993 | 0.099 | 0.000 |
| Gender | 14.075 | 1 | 12.075 | 0.207 | 0.650 |
| Error | 8330.203 | 80 | 48.655 | | |
| Total | 319787.000 | 83 | | | |
| Corrected Total | 8499.181 | 82 | | | |

? Not significant at 0.05 alpha level
The analysis in Table 9 indicates that there was no significant difference in retention of male and female Chemistry students taught using problem solving. The main effect of the treatment Group1 (problem solving) on gender alone produced an F (1, 82) = 0.21, p = 0.65. This result was not significant at the 0.05 $\alpha$ – level. This hypothesis is therefore not rejected. This indicated that male students' retention did not differ significantly from the influence of gender (male and female) when both were taught using problem solving.

**Summary of Findings**
The major findings obtained from the analysis of covariance (ANCOVA) on the research hypotheses of this study are summarized as follows:

(i) There was no significant difference between the achievement of male and female students exposed to Chemistry using guided discovery
(ii) There was no significant difference in the achievement of male and female students taught Chemistry using problem solving.
(iii) There was a significant difference in the retention scores of male and female students taught Chemistry using guided discovery strategy.
(iv) There was no significant difference in the retention scores between male and female students taught Chemistry using problem solving.

**Discussion of Findings**
The results of the analysis showed that gender has no significant difference on achievement of Chemistry students taught using guided discovery and problem solving strategies. This implies that Chemistry achievement is independent of gender. This might be due to similar active

participation of both male and female students during Chemistry lessons, and all-inclusive nature of the teaching methods used for the study. This finding concurs with the earlier works of Kosk and Finkelstein (2009) in Introductory Physics; and Olashinde and Olatoye (2014) in Science. On the other hand, it also contradicts the findings of Iwendi (2009) in Mathematics and Abdul-Raheem (2012) also in Mathematics that gender significantly enhances the students' achievement.

The influence of gender on the student's retention in Chemistry when taught using guided discovery and problem solving was examined using hypotheses five and six. The results of the analysis showed that gender has no significant effect on the retention of Chemistry student when taught using problem solving strategy. This implies that retention ability of students in Chemistry is independent of gender when taught with problem solving.

This might be due to similar active participation of both male and female students during Chemistry lessons, and all-inclusive nature of the teaching method used for the study. This finding concurs with the earlier works of Kosk and Finkelstein (2009) in Introductory Physics; and Olashinde and Olatoye (2014) in Science. On the other hand, it also contradicts the findings ofboth Iwendi (2009) and Abdul-Raheem (2012) in Mathematics that gender significantly enhances the students' retention.

On the other hand, gender has influence on the retention ability of students taught Chemistry using guided discovery and this might be as a result of female being phobia of carrying out experiments on their own without showing them how to do it as in the problem solving where teacher performs one experiment and asks the students to do the same thing or something even more complex than he has demonstrated. This is in line with earlier findings of Iwendi (2009) as well as Abdul-Raheem (2012) in Mathematics that gender significantly enhances the students' retention, but it contradicts the earlier findings of Kosk and Finkelstein (2009) in Introductory Physics, and Olashinde and Olatoye (2014) in science which show that gender has no effect on retention ability when male and female students exposed to the same concept using the same strategy.

**Implications of the Findings**

Based on the findings of this study, the following implications can be drawn:
The findings have strong implications for teaching and learning of Chemistry in secondary schools in Nigeria.

Both male and female students benefited from guided discovery and problem solving but male outperformed their female counterparts most especially in guided discovery group. It shows that both male and female students can be exposed to these strategies to improve their achievements in Chemistry with heavy monitoring of female students in each group. This implies that students irrespective of gender can learn effectively if the teacher can employ instruction and strategy that promote interaction, teamwork and active participation of students.

The findings have shown the effects of guided discovery and problem solving on retention ability of students in each group, and it has been discovered that these instructional strategies increase retention of Chemistry students in secondary schools. Therefore, guided discovery and problem solving instructional strategies are recommended for teachers' use for Chemistry instruction.

**Conclusions**

This study revealed that the achievement of Chemistry students in Minna Metropolis is independent of gender as significant difference in mean achievement scores between male and female students was not found. It was also observed that when a multitude of instructional

strategies are used there can be some difference in the retention ability between male and female students. In this study, it was found that the retention ability of male and female students are similar when taught with problem solving but the former outperformed the latter when taught with guided discovery method. It is concluded that achievement of Chemistry students in Minna Metropolis does not dependent on gender but retention ability does, depending on the instructional strategy that is adopted.

**Recommendations**

Based on the major findings of this study, the following recommendations are proffered:

(1) Teachers should expose Chemistry students to guided discovery and problem solving instructional strategies that promote and encourage social interaction, active learning, discovery learning, motivation, learning by doing and learning by experience which enhances achievement and retention of students.

(2) Secondary school teachers should be trained on how to use guided discovery and problem solving effectively in the classroom.

(3) The teacher education programme should be geared towards preparation of Chemistry teacher to acquire and maintain appropriate guided discovery and problem solving strategies which could be needed after training and which could be achieved if curriculum planner could make guided discovery and problem solving instructional strategies the essential instructional strategies for teaching and learning in the secondary school curriculum.

(4) The teacher education should be geared towards preparation of Chemistry teacher to acquire and maintain appropriate guided discovery and problem solving strategies which strongly enhance retention of Chemistry students at secondary school level

(5) Text book should be shifted from teacher-centered to learner-centered, activity-based learning such as guided discovery and problem solving strategies in the teacher's guide.

(6) Curriculum developers should embrace and include guided discovery and problem solving instructional strategies that will bring about improvement in learning, acquisition of critical thinking, social interaction, problem solving and performance skills in students into curriculum.

**References**

Abdu-Raheem, B. O. (2012). The influence of gender on secondary school student's academic Performance in south-west, Nigeria. *Journal of Social Sciences*, 31(1), 93-98.

Adesoji, F. A. & Fisuyi, M. O. (2001).Analysis of Problem Solving Difficulties of Students in Volumetric Analysis According to Gender. *Journal of Educational Studies, 1*(1),106-117.

Afonja, S. (2002). *Mainstreaming Gender in University Curriculum and Administration*. Paper Presented in Seminar at Centre for Gender Studies. Olabisi Onabanjo University, Ago Iwoye, Ogun State, Nigeria at the Annual Seminar of Social Sciences Academy.

Agbi, A. I. (2006). *Effects of interaction of teaching methods and study habit on students" achievement in chemistry.* Unpublished Ph.D. Thesis,University of Nigeria Nsukka, Nigeria.

Akuma, N. (2008). Effects of Guided Discovery Method on Senior Secondary Students, Interest in Map Work. *African Journal of Educational Research*, 12(2), 111 – 116

Alonge, M. F. (1989). *Measures and Evaluation in Education and Psychology* 2nd Edition.Ado-Ekiti.Adebayo Printers.

Archer, L. & Yamashita, H. (2003).Theorizing inner-city masculinities, race, class, gender and education. Gender and Education,2(34), 115-132.

Arnot, M. (2003). Male working class identities and social justice: A reconsideration of Paul Willies learning to labour in contemporary research, In carol Vincent (Ed): Social justice, education and identity: London: Routledge, Falmer, 97-119.

Azgaku, B. C. (2007). Disparities in gender relations and the family: A historical perspective. *Nigeria Journal of Social Research*, 2, 33-44.

Clerk, K. D. & Rutherford, M. (2000).The influence of teachers' instructional methods of students' interest in the learning of Chemistry. *International Journal of Science Education*, 22(7),703-717.

Elvan, E. G. & Mustafa, A. (2010).Effects of problem solving method on science skills and academic achievement. *Journal of Turkish Science Education,*7(4),*18-25.*

Geist, E. A. & King, M. (2008). Different, not better: Gender differences in Mathematics learning and achievement. Journal of Instructional Psychology, 35(1), 43- 52.

Ibraheem, I. (2001).Winning More Girls & Women for Science and Technology and Mathematics Education in Nigeria *43rd Annual Conference Proceedings, STAN. Rivers State, Nigeria, University of Technology, 18-24.*

Iwendi, B. C. (2009). *The influence of gender and age on Mathematics achievement of* secondary *school students in Minna* , Niger State. Unpublished M. Tech. Thesis, Science Education Dept. FUT, Minna, Nigeria..

Kosk, L. E. Pollock, S. J. and Finkelstein, N. D. (2009). Characterizing the gender gap in introductory physics. *Physics Education Research*, 5(1), 1-14.

National Examination Council Chief Examiner Reports (2003-2013).

Njoku, Z.C. (2001). Primary School Teachers' Perception of the Problems of Girls in learning, Science, Technology and Mathematics Education in Nigeria.*43rd Annual Conference Proceedings, STAN. River State, Nigeria, University of Technology August, 2012,* 18-23.

Nwachukwu, C. O. (2013). *Achievement and interest of chemistry students exposed to co-operative and competitive learning.* Unpublished Doctoral Thesis. Nnamdi Azikiwe University.

Okafor, P. N.(2001). Participation of Women in Life Science and Cultural Issue: Which Way Forward? In O. Busari (Eds): Women in Science, Technology and Mathematics Education in Nigeria, *43rd Annual Conference Proceedings. STAN*, River State Nigeria, University of Technology, August 2013: 18-23..

Olashinde, K. J. and Olatoye, R. A. (2014).Comparison of Male and Female Senior Secondary students' Learning Outcomes in Sciences in Katsina, *Journal of Social Sciences*, 5(2), 517-523.

Olorundare, A. S. (2011).Correlates of poor academic performance of secondary students in the sciences in Nigeria. Paper presented at the Virgina State University Petersburg, Virgina United State of America.

Orimogbunje, T. O. Oloruntegbe, T. O. & Gazi, M. A. (2010). An investigation into students" study habit in volumetric analysis in the senior secondary provision: A case study in Ondo State Nigeria. *African Journal of Pharmacy and Pharmacology*, 4(6),324-329.

Plummer, G. (2000).Failing Working Class Girls. Stoke on Trent: Tretham Books.

Popoola, A. A. (2002). *Effects of Heuristic Problem Solving and Programmed Instructional Strategies on Senior Secondary Schools. Students' Learning Outcomes in Mathematics in* Ekiti State, Nigeria, Ph,D. Thesis, Unpublished Ibadan: University of Ibadan.

Popoola, S. T. (2002). Effects of guided discovery techniques lecture method on students learning outcome in selected ecological concept. *Journal of Environment Education, 32 (2), 22-31.*

Sabiru, D. Y. (2014). Effects of collaborative learning on Chemistry students" Academic achievement and anxiety level in balancing chemical Equations in secondary school in Katsina Metropolis, Nigeria. *Journal of Education and Vocational Research, 5(2),43-48.*

Schmidt, H. J. (2000). In the maze of chemical nomenclature. How students' named oxosalts. *Instructional Journal of Science Education*, 22(3),225-238.

West African Examination Council (2010 – 2014).