

Effects of Personalised and Group-Based Mastery Learning Strategies on Students' Retention in Chemistry in Secondary Schools in Akwa Ibom State, Nigeria

Michael Saviour Udoh¹;

Prof. A. O. Ovute¹

¹Department of Science Education,
Michael Okpara University of Agriculture, Umudike, Abia State.
Email: udomysave2016@gmail.com

and

Dr Namkere J. Udoudo²

²Department of Industrial Technology Education,
University of Uyo, Akwa Ibom state, Nigeria
Email: namkerejudoudo@uniuyo.edu.ng

Abstract

The study determined the effects of personalised and group-based mastery learning strategies on students' retention in Chemistry in secondary schools in Akwa Ibom State. Three specific purposes, two research questions and three hypotheses guided the study. The quasi-experimental, pre-test, post-test research design was used. The population of the study comprised 16,786 senior secondary two students from the 253 public secondary schools in the state. A sample of 146 students (84 boys and 62 girls) was selected from three intact classes using multi-stage procedure and purposive sampling technique. Two instruments were used in the study namely Mastery Learning Instructional Packages (MLIP) and Chemistry Achievement Test (CAT). The MLIP were face validated by three lecturers from Michael Okpara University of Agriculture, Umudike, Abia State while the CAT was subjected to content validation. The reliability of the CAT obtained through test-retest method was 0.84. The mastery learning instructional packages constituted the treatment that was given to the experimental groups 1 and 2 while the control group was taught with the conventional lesson plans. The experiment lasted for six weeks covering six lessons. The mean and standard deviation were used to answer the research questions while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. It was found that **there** was significant difference in the mean retention scores of students in Chemistry when taught with personalized and group-based Mastery Learning Strategies and lecture method. There was no significant difference in the mean retention scores of male and female students in

Chemistry when exposed to Mastery Learning Strategies. Moreover, there was no significant interaction effect of teaching strategy and gender on students' retention in Chemistry. It is recommended, among others, that Chemistry teachers in Akwa Ibom state secondary schools should henceforth adopt the mastery learning strategies (personalized and group-based) in teaching important concepts in Chemistry while the lecture method **should be de-emphasized**.

Key words: Mastery learning Strategies (personalized and group-based), retention, Chemistry, gender

Introduction

Chemistry is undoubtedly one of the most significant science subjects taught in Nigerian schools from the secondary to the tertiary education level. It is that branch of science which is concerned with the study of matter as it relates to energy as well as the study of laws that determine the structure of the universe with reference to the matter and energy in the universe (Amos and Mkpa, 2023). Chikendu (2022) noted that Chemistry is popularly referred to as the "Central Science" because understanding of its notions about the structure and composition of matter is required for continued study in all sciences. In addition, Chemistry serves as a gatekeeper for secondary school students interested in studying pure and applied science, medicine, pharmacy, engineering, agriculture, and other science and technology related vocations (Amos and Mkpa, 2023). In view of its abstract nature, there is need for the use of innovative teaching strategies that would facilitate meaningful learning among the students. One of such strategies is mastery learning strategy.

Mastery learning is an instructional approach where students need to demonstrate a deep level of understanding of a topic or unit before progressing into another topic or unit. Mastery in this context refers to the ability for students to master, have full knowledge of and become proficient (expert) in a particular topic or concept. Salihu and Francis (2018) described Mastery Learning as an instructional method where students are allowed unlimited opportunities to demonstrate mastery of content taught. The strategy allows students to repeatedly study material until they master it. Mastery of each unit is shown when the student acquires competencies evident by the set pass mark of a diagnostic test. The authors added that mastery learning strategy helps the students to acquire prerequisite skills before moving to the next unit. The teacher also is required to do task analysis and state the objectives clearly and explicitly before designating the activities.

According to Ogini, Akinola, Fadiji & Amole (2021), mastery learning strategy was developed by Benjamin S. Bloom and the method consists of different steps. The Australian Educational Research Organization (AERO, 2021) outlined the steps involved in mastery learning as follows:

- i. Breaking down units of work into tasks with clearly specified objectives.
- ii. Identifying the set of learning objectives that your students need to address and describe how they will show evidence of mastery.

- iii. Designing tasks for your lessons that explicitly teach students each of the skills or understandings required in order to show mastery.
- iv. Sequencing the tasks so that they build upon each other.
- v. Explaining to students how each task is related and builds upon the last.
- vi. Using formative assessment to monitor students' understanding and progress.
- vii. Ensuring that students receive frequent and specific feedback.
- viii. Using information from the formative assessments to reflect and refine your own teaching.
- ix. Providing opportunities for revision and enrichment.
- x. Re-teaching tasks to students who have not met the learning objectives.
- xi. Providing enrichment opportunities in class for students who demonstrate early mastery.
- xii. Once students have mastered an objective, plan opportunities for review and space practice sessions over time.

There are two popular models of mastery learning strategies namely individualized or personalized model (also known as Keller's model) and group-based model (otherwise known as Bloom's model). Both models adopt the same procedure except that while the individualized model seeks to promote mastery learning of a pre-specified set of objectives for each learner in a subject or course, the Group-Based model seeks to promote mastery learning of a unit of instruction for all members of a class or group in a subject or course. This study used both the personalised and group based models of mastery learning for the experimental groups 1 and 2 respectively while lecture method was used for the control group in order to compare the effectiveness of the three methods on the students' retention of learning in Chemistry.

Retention is the ability to recall or remember what has been taught after a given time as a measure of students' progress (Eze, *et al*, 2016). Several scholars such as Filgona, Filgona and Sababa (2017) and Oginni, *et al* (2021) have identified instructional method as one of the major factors affecting students' academic achievement and retention of learning in various subjects. It is worthy of note that students' retention of learning may vary according to the students' gender. Gender refers to the difference between boys and girls in socio-cultural aspects rather than physical difference only. Several studies have been conducted to examine the effects of mastery learning strategies on students' retention in many subjects. For instance, Filgona, *et al* (2017) studied the effects of Mastery Learning Strategy on Senior Secondary School students' achievement and learning retention in Physical Geography in Ganye Educational Zone, Nigeria. The results showed that Mastery Learning Strategy improved students' learning retention and achievement in all levels of the cognitive domain in Physical Geography better than the Conventional Method. Similarly, Akpan and Tom (2023) examined the effect of Mastery Learning on Secondary School Students' Academic Performance and Retention in Basic Science and Technology in Etinan Local Government Area of Akwa Ibom State. The findings showed that students who were taught basic science and technology using mastery learning had better performance and retention scores than those who were taught using the expository method. It was also found that gender had no significant influence on the academic performance and retention of students taught basic science and technology using mastery learning strategy. Moreover, Jack (2019) studied the effect of mastery learning instructional strategy on secondary school students' achievement and retention of chemistry concepts. The

result showed that students exposed to MLIS achieved significantly better than those taught using Lecture and demonstration method. The result also showed that there was no significant difference between the mean achievement scores of male and female students in chemistry. Furthermore, Reuben and Ogheneakoke (2021) studied the effects of mastery learning on academic Performance of upper basic social Studies students in Delta state. The results revealed that the effect of mastery learning strategy is better than lecture method for teaching and learning Social Studies at the Upper Basic level. Findings also show a significant interaction effect of instructional strategies and gender on the academic performance and retention of students in Upper Basic Social Studies. Based on the foregoing, it becomes imperative to explore the efficacy or otherwise of mastery learning strategies on secondary school students' retention of learning in Chemistry in Akwa Ibom state.

Statement of the Problem

It is very disheartening to observe that students' academic achievement and retention of learning in Chemistry in the senior secondary school certificate examinations are below expectation as indicated by chief examiners reports from examination bodies like the West African Examinations Council (WAEC) and National Examinations Council (NECO). This has been an issue of great concern to science educators considering the relevance of Chemistry education to the nations' development. Despite much efforts by chemistry teachers to improve students' learning outcomes, many students still struggle to understand and retain chemistry concepts. Researches by *Jack (2019)*, Reuben and Ogheneakoke (2021) and Akpan and Tom (2023) attributed the poor ability of students' to retain Chemistry concepts to the use of poor instructional strategies by most chemistry teachers. It is observed that the teaching method commonly used by chemistry teachers in secondary schools in Akwa Ibom State is the lecture method which is a teacher-centred method that does not emphasize mastery of previous lessons before a new one, hence, it may not be effective in facilitating deep learning and understanding among students. The method does not provide opportunity for teachers to explain the concepts to students in a simple and step by step presentation. When students cannot link what they are being taught with practical experiences, it brings about low interest in that subject which is manifested in their poor academic performance and poor retention of learning. In view of these limitations, there is need to explore new strategies such as mastery learning instructional strategies.

Despite the numerous documented empirical evidences on the effectiveness of mastery learning strategies (personalized and group-based) in improving students' academic achievement and retention of learning in many subjects, not much work has been done on its effect on students' retention of learning in Chemistry in secondary schools in Akwa Ibom State. The absence of research studies that address these issues therefore solicits a study to answer the question: What are the effects of mastery learning strategies on students' retention of learning in Chemistry in secondary schools in Akwa Ibom State?

Purpose of the Study

The main purpose of the study was to determine the effects of mastery learning instructional strategies (personalized and group-based) on Secondary Schools students'

retention of learning in Chemistry in Akwa Ibom State. The specific objectives of the study are:

- i. To determine the difference in the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method.
- ii. To ascertain the difference in the mean retention scores of male and female students in Chemistry when exposed to Mastery Learning Strategies (personalized and group-based) and lecture method
- iii. To determine the interaction effects of teaching strategies and gender on the mean retention scores of students in Chemistry.

Research Questions

The following research questions guided the study:-

- i. What is the difference in the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method?
- ii. What is the difference between the mean retention scores of male and female students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method?

Hypotheses. The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance:

HO 1: There is no significant difference in the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method.

HO 2: There is no significant difference between the mean retention scores of male and female students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method.

HO 3: There is no significant interaction effect of teaching strategies and gender on the mean retention scores of students in Chemistry.

Research Methodology

The quasi-experimental research design, specifically, non-equivalent pre-test - post-test control group design was used in the study. The study was conducted in Akwa Ibom State which is one of the 36 states in Nigeria. The population of the study consisted of 16,786 senior secondary two (SSII) chemistry students from all the 253 public secondary schools in the state. A sample of 146 SS II students made up of 84 boys and 62 girls was selected from three intact classes in three co-educational secondary schools in the study area using Multi-stage procedure and purposive sampling technique. Balloting was thereafter used to assign each of the selected three intact classes to the two experimental groups and a control group.

Three instruments were used in the study. They were: Mastery Learning Instructional Packages (MLIP), Lecture method Instructional Packages (LMIP) and Chemistry Achievement

Test (CAT). The Chemistry Achievement Test which comprised 50 multiple choice items with four options lettered A- D was used as pre-test, post-test and retention test after being reshuffled after each administration. Face validation of the MLIP was done by three experts from Michael Okpara University of Agriculture, Umudike while the content validation of the CAT involves the development of a test blueprint or table of specification. The reliability coefficient of the Chemistry Achievement Test (CAT), was 0.84 obtained using test-retest method.

The students in the selected intact classes were randomly assigned by the researchers to the three study groups as follows: Group I (Personalized mastery learning Strategy); Group II (Group based mastery learning and Group III (Control group, Lecture method). The subjects were subjected to pretesting before the experiment using the CAT. The experiment lasted for six weeks and six lessons were covered. Students in the various groups were taught using the relevant instructional packages. Post-testing was done immediately after the experiment. Two weeks after the post-test, they were subjected to the retention test. Data collected were analysed using mean and standard deviation to answer the research questions raised while the hypotheses formulated were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. Post hoc pair wise comparison was employed, where necessary.

Results

Research Question 1: What is the difference between the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method?

Table 1: Mean Post-test and Retention scores of students in Chemistry when taught using Mastery Learning Strategies and lecture method

S/n	Group	N	Post test \bar{X}	SD	\bar{X}	Retention SD	Mean and % gain
1	Personalised Mastery Learning	48	62.08	3.64	69.00	3.11	6.92 %
2	Group-based Mastery Learning	49	60.37	1.84	66.88	8.88	6.51 %
3	Lecture Method	49	53.53	3.31	57.10	3.16	3.57 %

The result in Table 1 shows the mean post-test, retention test scores as well as mean gain of students in Chemistry in the three groups based on teaching strategy namely Mastery Learning Strategies (personalized and group based) and lecture method. It could be observed that students who were taught using personalized mastery learning strategy obtained the highest mean gain of 6.92 representing 6.92% as against 6.51 (6.51%) and 3.57 (3.57%) obtained by those who were taught using group-based mastery learning strategy and lecture method respectively. This result suggests that teaching chemistry using personalized mastery learning strategy enhances students' retention in the subject than using the group-based mastery learning strategy and lecture method.

Research Question 2

What is the difference between the mean retention scores of male and female students in Chemistry when taught with Mastery Learning Strategies and lecture method?

Table 2: Mean Post-test and retention test scores of students in Chemistry based on gender when taught using Mastery Learning Strategies and lecture method

Group	Gender	N	Post test		Retention		Mean and % gain
			\bar{X}	SD	\bar{X}	SD	
Personalized	Male	22	62.64	4.29	70.00	2.89	7.36%
	Female	26	61.62	2.99	68.15	3.09	6.53%
Group based	Male	23	64.35	9.08	69.48	4.09	5.13%
	Female	26	56.85	1.22	64.58	1.17	7.73%
Control	Male	39	52.80	3.74	57.60	2.83	4.83%
	Female	10	54.29	2.66	56.58	3.46	2.24%

The result in Table 2 shows that the mean post-test and retention test scores of male students in experimental group one who were taught with personalized mastery learning method are 62.64 and 70.00 respectively with standard deviations of 4.29 and 2.89. It could be observed that male students in experimental group 1 obtained the highest mean gain of 7.36% as against 6.53% obtained by their female colleagues. Also, female students in experimental group 2 obtained a higher mean gain of 7.73% as against 5.13% obtained by their male colleagues. This result suggests that teaching chemistry using personalized mastery learning strategy enhances male students' retention in the subject more than the female students while the group-based mastery learning strategy enhances female students' retention in the subject more than the male students.

Hypothesis 1 (HO 1): There is no significant difference between the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies and lecture method.

Hypothesis 2 (HO 2): There is no significant difference between the mean retention scores of male and female students in Chemistry when taught with Mastery Learning Strategies (personalized and group-based) and lecture method.

Hypothesis 3 (HO 3): There is no significant interaction effect of teaching strategies and gender on the mean retention scores of students in Chemistry.

Data related to hypotheses 1, 2 and 3 is presented in table 3

Table 3: Analysis of Covariance test for significant difference in the mean retention scores of students in Chemistry based on gender when taught with Mastery Learning Strategies and Lecture method

Source	Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	4271.03	5	854.20	27.32	0.00	
Intercept	603173.56	1	603173.56	19291.39	0.00	
GROUP	3995.45	2	1997.72	63.89	0.00	S
GENDER	243.54	1	243.54	7.79	0.06	NS
GROUP * GENDER	102.102	2	51.05	1.63	.199	NS
Error	4377.30	140	31.26			
Total	612181.00	146				
Corrected Total	8648.33	145				

*S = Significant; NS = Not Significant at 0.05 level of significance

Table 3 shows that the f -value for group or teaching strategy is 63.89 with p-value (probability value) being 0.00 which is significant at 0.05 level of significance. On this basis, null hypothesis 1 is rejected implying that there is significant difference in the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies and lecture method. Turkey's post hoc test was conducted to determine where the significant difference comes from as shown in Table 4.

Table 3 also shows that the f -value for gender is 7.79 with p- value (probability value) being 0.06 which is not significant at 0.05 level of significance. On this basis, the null hypothesis is upheld implying that there is no significant difference in the mean retention scores of male and female students in Chemistry when exposed to Mastery Learning Strategies and lecture method. Table 3 further revealed that the F-value for interaction effect of teaching strategy and gender on the mean retention scores of students in Chemistry is 1.63 with p-value being 0.199 which is not significant at 0.05 level of significance. On this basis, the null hypothesis is upheld implying that there is no significant interaction effect of teaching strategy and gender on the mean retention scores of students in Chemistry when exposed to Mastery Learning Strategies and lecture method.

Table 4: Summary of Turkeys' Post-hoc Pairwise comparison of the mean Retention Test scores of the three groups

Dependent Variable: Retention -Test Score

Groups	Mean Difference	Standard Error	Sig	Remarks
1 Vs 2	2.122	1.167	0.167	NS
1 Vs 3	11.898**	1.167	0.000	S
2 Vs 1	-2.122	1.167	0.167	NS
2 Vs 3	9.775**	1.161	0.000	S
3 Vs 1	-11.898**	1.167	0.000	S
3 Vs 2	-9.775**	1.161	0.000	S

Based on observed means (raw scores). The error term is Mean Square (Error) = 47.519. The mean difference is significant at the .05 level.

The summary of Turkey's post hoc **pairwise comparison** of the mean difference in the retention test scores of students in the three groups presented in Table 4 shows that the mean difference between group 1 (personalized) and group 2 (group-based) as well as between groups 2 and 1 were not significant at 0.05 level of significance. Significant difference were however found in the mean difference between group 1 (personalized) and group 3 (lecture method), between groups 2 and 3, 3 and 1 as well as between groups 3 and 2. This result implies that the mean retention test scores of students in the two experimental groups were significantly better than those in the control group. The significant difference is therefore attributed to experimental group 1 students who obtained a higher retention test score than those in the other two groups as seen in Table 1

Findings of the Study

It was found that students taught chemistry using personalized mastery learning strategy performed better in the retention test than those who were taught using group-based mastery learning strategy and lecture method. **There** was significant difference in the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies and lecture method. The difference is in favour of experimental group 1 who were taught using personalized mastery learning strategy. **There** was no significant difference in the mean retention scores of male and female students in Chemistry when exposed to Mastery Learning Strategies and lecture method. **There** was no significant interaction effect of teaching strategy and gender on the mean retention scores of students in Chemistry when exposed to Mastery Learning Strategies and lecture method.

Discussion of Findings

In the study, it was found that **there** was significant difference in the mean retention scores of students in Chemistry when taught with Mastery Learning Strategies and lecture method. The difference was in favour of experimental group 1 who were taught using personalized mastery learning strategy. This result could be attributed to the fact that in personalised mastery learning strategy, the teacher pays close attention to each student personally and this enables the students to understand a unit of instruction very well before proceeding to the next unit. This finding agreed with that of Filgona, et al (2017) who found that Mastery Learning Strategy improve students' learning retention and achievement in Physical Geography better than the Conventional Method. The finding also supports that of Jack (2019), Akpan and Tom (2023) and Tahir and Faruk (2024) who in their separate studies found that mastery learning approach (MLA) significantly enhance students' achievement and retention than when using the conventional method.

It was also found in the study that **there** was no significant difference in the mean retention scores of male and female students in Chemistry when exposed to Mastery Learning Strategies and lecture method. This finding agreed with that of Jack (2019) who found that there was no significant difference between the mean achievement and retention scores of male and female

students in chemistry when taught using mastery learning strategy. The finding also supports that of Akpan and Tom (2023) who found that gender had no significant influence on the academic performance and retention of students taught basic science and technology using mastery learning strategy.

It was further found in the study that **there is no significant interaction effect of teaching strategy and gender on students' retention in Chemistry**. This implies that the combined effect of teaching strategy and gender does not have significant influence on students' retention in Chemistry. This finding contradicts that of Reuben and Ogheneakoke (2021) who studied the effects of mastery learning on academic Performance of upper basic social Studies students in Delta state. The results revealed that there was a significant interaction effect of instructional strategies and gender on the students' academic performance and retention in Upper Basic Social Studies

Conclusion

Based on the findings of the study, it is concluded that teaching Chemistry using personalized and group-based mastery learning strategies enhances students' retention of learning than using the lecture method. Also, the personalized Mastery Learning strategy is favourable to both male and female students with respect to retention of learning. Moreover, **the combined effect of teaching strategy and students' gender do not have significant influence on students' retention in chemistry when taught using Mastery Learning strategies**.

Recommendations

The following recommendations are made based on the findings of the study.

1. Government of Akwa Ibom State should ensure that Chemistry teachers in secondary schools in Akwa Ibom state henceforth adopt the personalised mastery learning strategy in teaching important concepts in Chemistry
2. Curriculum developers in Chemistry should recommend personalized and group-based Mastery learning strategies as one of the teaching strategies in order to improve students' achievement and retention in the subject.

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