EFFECTS OF MASTERY AND ACTION LEARNING STRATEGIES ON STUDNETS' ACHIEVEMENT IN CHEMICAL EQUILIBRIUM IN UYO SENATORIAL DISTRICT

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ABSTRACT

The study investigated the effects of mastery and action learning strategies on students' achievement in chemical equilibrium in Uyo Senatorial District of Akwa Ibom State. Three research questions and three hypotheses guided the study. The study adopted a quasi-=-experimental design in a non-randomized pretest, posttest setting. The study comprised 206 SS2 chemistry students in public coeducational secondary schools in the study area selected using multi-stage sampling technique. Instrument for gathering data of the study was Achievement Test on Chemical Equilibrium that measured students' achievement with a reliability index of .86. The data obtained were analyzed using mean, standard deviation and analysis of Covariance (ANCOVA). The result showed that students taught using mastery learning strategy had the best achievement. Students taught using action learning and those taught using expository teaching strategy had comparable achievement. Gender and school location had no significant influence on students' achievement. Consequently, it was recommended, among others, that chemistry teachers should adopt mastery learning strategy in teaching chemistry.

KEYWORDS: Mastery learning, Action learning, Academic Achievement, Chemistry.

INTRODUCTION

Chemistry has long been made an integral part of academic curriculum in schools. It is a core subject in the study of many courses such as Medicine, Pharmacy, Biochemistry, Microbiology, Engineering, Agriculture and Printing Technology. A sound knowledge of chemistry is therefore, of great importance to many students, community and society at large. Considering this critical role of chemistry, it is needful to lay a solid foundation in students to enhance their academic performance. (Umanah, 2017). Furthermore, Nigeria and the world over are talking about sustainable development, for which chemistry cannot be set aside, nor separated from the plans to achieve sustainable development. In order for the students to participate meaningfully, there is a need to equip them with necessary lifelong or process skills such as communication, decision making skills, information searching and utilization skills, thinking skills and leadership skills (Daniel, 2021). Acquisition of appropriate scientific and technological knowledge and skills are necessary to cope with the challenges presented by the evolving needs of modern work place in our industries and overgrowing non-formal sector (Ajayi & Ogbeda, 2017)

Chemistry is a relevant and experimental science subject that demands proactive teaching method with effective students' involvement using hands-on and minds-on experiences to generate knowledge and develop scientific skills (Shadreck & Chukunoye, 2018). Given its application in

many professions, it is necessary that every student be given an opportunity to acquire knowledge of its concepts, principles and skills. Unfortunately, the teaching and learning of chemistry has been fraught with challenges which prevent optimum achievement of the objectives of chemistry education in national development and many students from performing well in external examinations such as the West African Senior School Certificate Examination (WASSCE) and National Examination Council Senior Secondary School Certificate Examination (NECO SSCE). It is a well-documented fact in science education literature that many students at all level struggle to learn chemistry (Ekanem & Daniel, 2022). With the rate at which scientific and technological inventions are gaining popularity all over the world, the training of the mind is a must. The students should be thoroughly equipped with relevant knowledge and skills for viable functionality and ability to cope with many intellectual and cultural challenges which the rapidly changing environment may demand in future.

In attempts to tackle the above task, the Federal Government of Nigeria formulated goals as spelt out in the National Policy on Education (NPE, 2013) that reflected among others, the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies to empower the individual to live in and contribute positively to the development of the society. In addition, the need to use activity-oriented and learner-centered method of teaching is emphasized in the National Policy on Education (NPE, 2013). It states that educational activities shall be learner-centered for maximum self-development and self-fulfillment and the education system shall be structured to develop the practice of self-learning. This calls for the use of teaching strategies in which the learners play the most active part in the learning process. Despite the prime position Chemistry occupies in Nigeria educational system and efforts made by Curriculum development bodies and researchers to enhance students' academic achievement and inspite of the emphasis placed on science and technology, it is observed that students' academic achievement in chemistry has consistently been below expectation and unimpressive. (Daniel, 2021; Ndukwe, 2021; Ekanem & Daniel, 2022, WAEC Chief Examiners Report, 2020, 2021, 2022 and 2023).

Researchers have identified several factors responsible for students' poor performance in chemistry to include the following: the abstract nature of the concepts of chemistry (Noah & Sanger, 2012) students' lack of sufficient prior knowledge and cognitive development (Shadreck & Chuknoye, 2018), students' psychological development and mathematical anxiety (Nbina and Obomanu, 2011), misconceptions by teachers and students (Gongden 2016), lack of interest and confidence by Chemistry students in their approach to tackling chemistry problems (Umanah, 2017).

According to West African Senior School Certificate Examination (WASSCE) Chief Examiner's report (2020-2023) low academic performance in Chemistry has been attributed to factors such as students' poor communication skills, poor study habits, abstract nature of the subject, poorly equipped laboratory and lack of experienced Chemistry teachers.

The problem of poor academic performance in Chemistry among Senior Secondary Schools Chemistry students has been of much concern to Chemistry Educators, Achimugu (2013) asserted that for learning to be meaningful and effective in Chemistry classrooms, the teacher should be able to select appropriate teaching strategy that would stimulate the interest of the learners and get them actively engaged in the process of learning. According to Bamiro (2015), a key determinant of students' achievement in Chemistry is the quality of instructional strategies employed by Chemistry teachers. Teaching methods are the tools of the teacher in reaching the set goals and instructional objectives (Umanah, 2017). If the tools are faulty or inappropriate, instructional goals and objectives may not be achieved. Mastery learning and Action learning strategies are all based on constructivism. Constructivism learning is often associated with pedagogic approaches that promote active learning, or learning by doing.

Mastery learning is a remedial process aimed at bringing students to a level of mastering a

concept. Udo and Udofia (2014) sees it as an innovative strategy designed to make students perform beautifully well in an academic task. Frequent assessment and feedback; corrections with emphasis on cues; motivation; allotment of more time on tasks; and Reinforcement through assignments. Action learning, on the other hand, is an educational process whereby the participant studies his/her own actions and experiences in order to improve performance (Adeyemi 2020). It enables each student to reflect on and review the action he/she has taken and the learning points arising, this would then guide future action and improves performance. It is therefore hoped that a better understanding of the effects of mastery and action learning strategies will serve to evolve an effective plan for enhancing students' achievement and retention of the concept of Chemical equilibrium.

Researchers report that mastery learning and action learning strategies foster high academic achievement in science and chemistry in particular (Furu, 2014; Udo and Udofia, 2014; Mites and Obaitan, 2015; Adeyemi, 2020; Adigun, 2021; and Ogbonna & Ismaila, 2021). However, it seems the use of mastery learning and action learning strategy has not attracted much attention as chemistry classroom activities are still dominated by teacher-centered methods. Hence, there should be paradigm shift from teacher-centered learning to student-centered learning through the use of mastery and action learning strategies. This had therefore made it necessary to investigate the relative effectiveness of mastery learning and action learing strategies on senior secondary school chemistry students' achievement on the concept of chemical equilibrium in Uyo Senatorial District of Akwa Ibom State. The findings of this study would be beneficial to science teachers, Curriculum Planners, Ministers of Education and Educational Researchers.

PROBLEM STATEMENT

The Senior Secondary School Chemistry curriculum has some concepts that are deemed difficult by the teachers to teach and students to learn. One of such concepts is chemical equilibrium. The main aim of science teaching is to promote the understanding of the concept being taught with a view to applying the knowledge of such understanding to real life situations. Unfortunately, students' performance in Chemistry continue to record a persistent and depressing downward trend.

Methods used in teaching Chemistry do not seem to help in improving students' academic achievement. It is therefore inevitable to try out other instructional strategies that could enhance effective teaching and learning of Chemistry. The problem of the study is to determine if students' achievement can be enhanced when taught with mastery, action or conventional strategies and which of the learning strategies, mastery or action learning strategies will prove more effective in facilitating students' achievement in the concept of Chemical equilibrium? This study is an attempt to find answers to these questions.

RESEARCH QUESTIONS

In order to achieve the above stated objectives, the following research questions were raised to guide the study:

- How do students differ in their mean achievement scores on Chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies?
- What difference exists among the mean achievement scores of students on chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies based on gender?

- What difference exist among the mean achievement scores of students on chemical equilibrium when taught mastery learning, action learning and conventional expository teaching strategies based on school location?

RESEARCH HYPOTHESES

The following hypotheses were formulated and tested at .05 alpha level.

- There is no significant difference among the mean achievement scores of students in chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies.
- There is no significant difference among the mean achievement scores of male and female students in chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies.
- There is no significant difference among the mean achievement scores of urban and rural students in chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies.

RESEARCH METHODOLOGY

A quasi-experimental design was used with a 3x2x2 factorial arrangement in a non-randomized pre-test, post-test setting. It is factorial design with treatment varying at 3 levels, gender at 2 levels and school location at 2 levels. This study is described as non-randomized since intact classes from selected schools were used for the study. The pre-test provided a check on the non-random assignment of subjects to the groups. Moreover, comparison on the basis of pretest performance provided further process of equating the research groups.

The study was conducted in Uyo Senatorial District of Akwa Ibom State. Uyo Senatorial District comprised of nine local government areas namely: Etinan, Ibesikpo Asutan, Nsit Ibom, Nsit Atai, Nsit Ubium, Itu, Ibiono Ibom, Uruan and Uyo.

There are 55 public coeducational secondary schools and one university in the area. The research chosed the area for the study because of the strategic position in this area. First, it hosts one tertiary institution – the University of Uyo, Uyo, secondly, it is the seat of the government of Akwa Ibom State. By this status the schools in this district are well staffed. Hence, the students can be expected to respond well to the experiment.

The population of the study consisted of all the 6,922 SS2 Chemistry students in all the (55 public co-educational secondary schools in Uyo Senatorial District of Akwa Ibom State). The choice of Senior Secondary Two students is due to the fact that Chemical Equilibrium in usually taught in Senior Secondary Two. Thus, it is assumed that the students do not have any prior knowledge of the concept to be investigated. This enabled the researcher to genuinely investigate on students' academic achievement in Chemical Equilibrium.

The study sample comprised of 206 SS2 Chemistry students in six intact classes in six secondary schools in the study area selected using multi-stage sampling technique. First the study area was stratified into urban and rural strata. Next, three public co-educational secondary schools were randomly selected from each strata for the study using simple random sampling technique. Finally, one arm of intact SS2 class from each of the selected schools was randomly selected and assigned as either Experimental group 1, Experimental group II or control group. Thus, two schools each from the urban and rural strata were randomly assign as Mastery Learning Group, Action Learning Group and Expository Learning Group, respectively.

A researcher developed instrument tagged "Achievement Test on Chemical Equilibrium (ATCE)" was used in collecting data for the study. The instrument was a 50 item 4-option multiple

choice test with four options (A-D) designed to measure the achievement of students in Chemical Equilibrium. This instrument was used as a pretest to assess the equality of the group before treatment and reshuffled version of it was used as a pot test to assess the performance of the students after treatment.

In order to ensure face and content validity of Achievement Test on Chemical Equilibrium (ATCE) the instrument was submitted to three independent assessors, two content experts in Chemistry Education and one test and measurement expert, all in the Faculty of Education, University of Uyo. These validators were requested to vet the items for clarity of words, appropriateness to the level of students, content coverage, adequacy in addressing the objectives and problems of the study. Based on their comments and suggestions necessary modifications were made on the instrument

The researcher established the reliability of the research instrument from data that was obtained from the trial testing. The reliability of the instrument was determined using test-retest method. The trial test sample of the item analysis was used and the second test were administered two weeks after the first. Data generated were analyzed using Pearson Product Moment Correlation (PPMC) Coefficient r. The result showed that ATCE has a reliability index of 0.86. This indicated that the instrument is reliable and capable of measuring the intended outcomes.

After selecting the schools, the researcher visited the school principals to request for permission to use their school for the study. Thereafter, the subject teachers of the selected classes were requested to serve as research assistant, one week was used to brief them on the modalities of the research namely; administration of the research instruments, procedure in teaching chemical equilibrium using the validated notes developed by the researcher as related to the instructional strategies adopted. The use of research assistant was to control the treatment effect. At the end of the briefing session, the researcher assessed the research assistants as each of them taught (using their specific instructional strategies) in order to measure their level of compliance and to help where necessary.

Thereafter, the research assistants administered the ATCE to all he treatment groups as pre-test. This was done in order to establish the homogeneity of the group before the treatment. Thereafter, the lesson notes prepared by the researcher were used by the research assistants in teaching the concepts of Chemical Equilibrium in their respective groups for four weeks. The students in Experimental group 1 were taught using Mastery Learning strategy, those in Experimental group II were taught using Action learning strategy while those in the control group were taught using expository teaching strategy. The teaching in all the groups was done during the normal class periods for chemistry and in intact class setting. At the end of the treatment, the reshuffled version of the ATCE was administered to all the students as posttest under the supervision of the researcher. The scripts were collected at the end of the test by the research assistants who submitted same to the researcher for marking and scoring.

RESULT

In this section, the summary of results used in answering the three research questions and testing the three null hypotheses formulated to guide the study, are presented and interpreted variable by variable.

RESEARCH QUESTION

Research Question 1: How do students differ in their mean achievement scores on Chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies?

Table 1: Mean and Standard Deviation of students' pre-test and post-test scores classified by treatment groups

Treatment Groups	Sample Size	Pre-test		Post-test		Mean Difference
		$\bar{x}$	SD	$\bar{x}$	SD	
Mastery	63	43.94	15.00	62.06	15.65	18.12
Action	45	30.98	6.33	47.02	11.29	16.13
Expository	98	34.08	8.01	46.84	9.81	12.76

In table 1, the results shows that the students taught using Mastery learning strategy had the best post-test pre-test mean difference (18.12), followed by those taught using Action learning strategy (16.13), and those taught using Expository teaching strategy in decreasing rank order.

Research Question 2: What difference exists among the mean achievement scores of students on chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies based on gender?

Treatment Groups	Gender	N	Pretest		Posttest		Mean Gain
			$\bar{x}$	SD	$\bar{x}$	SD	
Mastery	Male	28	41.79	12.68	57.71	15.55	15.92
	Female	35	45.66	16.60	65.54	15.05	19.88
Action	Male	26	30.15	7.00	48.92	12.20	18.77
	Female	19	31.89	5.31	44.42	9.61	12.53
Expository	Male	37	34.11	7.70	45.68	10.23	11.57
	Female	61	34.07	8.25	47.54	9.57	13.47

In Table 2, the results shows that the female students taught using Mastery learning strategy had the best post-test pre-test mean difference (19.88), followed by the males taught using Action learning (18.77), the male in Mastery (15.92), the female in the Action learning (12.53), the female in the Expository teaching strategy (11.57), in decreasing rank order.

Research Question 3: What difference exists among the mean achievement scores of students on chemical equilibrium when taught mastery learning, action learning and conventional expository teaching strategies based on school location?

Table 3: Mean and standard deviation of students' pre-test and post-test scores classified by treatment groups and school location.

Treatment Groups	School Location	Sample Size	Pretest		Posttest		Mean Gain
			$\bar{x}$	SD	$\bar{x}$	SD	
Mastery	Urban	34	53.35	13.898	72.82	9.750	19.47
	Rural	29	32.90	6.038	49.45	11.160	16.55
Action	Urban	33	31.52	6.384	45.21	11.832	13.69
	Rural	12	29.17	6.118	52.00	8.090	22.83
Expository	Urban	42	32.48	6.337	46.62	9.693	14.14
	Rural	56	35.29	8.931	47.00	9.989	11.71

In Table 3, the result shows that the Rural students taught using Action learning strategy had the best post-test pre-test mean difference (22.83), followed by the Urban student taught using Mastery learning (19.47), the Rural students in the Mastery group (16.55), the Urban students in the Expository (14.14), the Urban students in the Action learning group (13.69), and the Rural in the Expository teaching strategy (11.71), in decreasing rank order. The observations show that the Action learning strategy facilitated the rural students' performances better than the Mastery and Exposition strategies.

RESEARCH HYPOTHESES

The following hypotheses were formulated and tested at .05 alpha level.

Hypothesis one: There is no significant difference among the mean achievement scores of students in chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies.

Table 4: Summary of Analysis of Covariance (ANCOVA) of students' post-test scores classified by treatment groups with pre-test as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<05 alpha
Present	7616.754	1	7616.754	68.359	.000	s
Treatment	2921.835	2	1460.917	13.112	.000	s
Error	22507.358	202	111.423	-	-	-
Total	587272.000	206	-	-	-	-
Corrected Total	40187.262	205	-	-	-	-

a. R Squared = .440 (Adjusted R Squared = .432)

In Table 4, the calculated F-ratio for the effect of instructional methods at df 2, 205 is 13.11 while its corresponding calculated level of significance is .00 alpha. This level of significance is less than .05 which the decision is based; indicating that there was a significant difference in the academic performance of students in the concepts taught using Mastery learning, Action learning

and Expository teaching strategies,. With this observation, null hypothesis 1 was rejected. This means that there is a significant difference among the mean scores of students on chemical equilibrium in Chemistry based on instructional strategies.
As regards the direction of significance the Scheff post-hoc summary indicates as follows:

Table 5: Summary of Scheffe Post hoc test of students' post-test achievement by treatment groups.

Ability	N	Subject		Mean Gain
		1	2	
Expository	98	47.84		
Action	45	47.02		
Mastery	63		62.06	
Sig		.996	1.00	

Alpha = 0.05

The mean for groups in homogenous subset displayed in Table 5 indicates that students taught using Mastery learning strategy performed significantly better than those taught using Action learning and Expository teaching strategies. While there was no significant difference between those taught using Action learning and Expository teaching strategies.

Hypothesis Two: There is no significant difference among the mean achievement scores of male and female students in chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies.

Table 6: Summary of Analysis of Covariance (ANCOVA) of male and female students' post-test scores classified by treatment with pre-test as covariance.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<05 alpha
Pretest	7259.55	1	7259.55	66.86	.00	s
Treatment	2891.50	2	1445.75	13.31	.00	s
Gender	19.34	1	19.34	.18	.67	ns
Treatment * Gender	801.78	2	400.89	3.69	.03	s
Error	216-8.58	199	108.59			-
Total	587272.00	206				-
Corrected Total	40187.262	205	-	-	-	-

a. R Squared = .462 (Adjusted R Squared = .446)

In Table 6, the calculated F-ratio for the main effect of instructional strategies at df 2, 205 is 13.31, while its corresponding calculated level of significance is .00 alpha. This level of significance is less than .05 in which the decision is based; indicating that there was a significant difference between the academic achievement of students in the concepts taught given the instructional methods used. However, the F-cal value for the main effect of gender given the instructional strategies at df 1, 205 was .18 while its significant level is .67. This significant level is greater than .05 alpha in which the decision is based, indicating that the influence of gender on the students' achievement was not statistically significant. With this observation, null hypothesis 2 was upheld.

Hypothesis Three: There is no significant difference among the mean achievement scores of urban and rural students in chemical equilibrium when taught using mastery learning, action learning and conventional expository teaching strategies.

Table 7: Summary of Analysis of Covariance (ANCOVA) of students' post-test scores classified by treatment groups and school location with pre=test as covariance

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<05 alpha
Pretest	2037.95	1	2037.95	21.21	.00	s
Treatment	3735.22	2	1867.61	19.43	.00	s
School Location	320.45	1	320.45	3.33	.07	ns
Treatment *School Location	2972.07	2	1486.03	15.46	.00	s
Error	19125.58	199	96.11	-	-	-
Total	587272.00	206	-	-	-	-
Corrected Total	40187.26	205	-	-	-	-

a. R Squared = .462 (Adjusted R Squared = .446)

In Table 7, the F-cal value for the main effect of school location given the instructional strategies at df 1,205 was 3.33 while its significant level is .07. This significant level is greater than .05 alpha in which the decision is based, indicating that the influence of school location on the students' achievement was not statistically significant. With this observation, null hypothesis 3 was upheld.

DISCUSSION OF FINDINGS

The findings of this research are discussed as follow:

The findings with regard to the effects of Mastery learning, Action learning and Expository teaching strategies on students' achievement on chemical Equilibrium in Chemistry showed that there was a significant difference on students' academic achievement. Students taught using Mastery learning strategy performed significantly better than those taught using Action learning strategy and expository teaching strategy; students taught using Action learning strategy and expository teaching strategy had comparable achievements. The better enhancing effect of Mastery learning strategy on students' academic achievement, which is in line with the findings of Majid and Zahra (2010), Furu (2014), Udo and Udofia (2014) Mites and Obaitan (2015) and Ogbonna and Ismaila (2021) underscores the importance of involving the learners in constant drill and practice until they master the given concept. However, the findings is at variance with Adeyemi (2020) and Adigun (2021) who observed that Action learning strategy is the most facilitative strategy in enhancing students' academic achievement in Chemistry

The findings with regards to the influence of gender on students' academic achievement when taught using Mastery learning, Action learning and Expository teaching showed that the influence of gender on student's achievements was not statistically significant. The reason could be due to the equal treatment given to both male and female students in the treatment groups. The instructional strategies are not gender sensitive, rather they give room for the two gender to perform equally. The findings agrees with Shadreck and Chukunoye (2018), Eya and Ezeh (2020) and Daniel

(2021) that there was no significant influence of gender on students'' achievement in Chemistry. However, the finding disagrees with Aniodoh and Egbo (2013), who observed that female students performed significantly better than male students in Chemistry. It also disagrees with Ezeudu and Obi (2013) who observed that male students achieved significantly better than female students in Chemistry.

With respect to the influence of school location given the instructional strategies used, the findings showed that its influence was not statistically significant. This could be attributed to the enhancing effects of the instructional strategies used. The no significant influence of school location reported in this study is in agreement with the findings of Agbaje and Awodun (2014), Daniel (2021) and Ekanem and Daniel (2022). Conversely, the finding disagrees with Chukwuka (2014) that Chemistry students in urban schools achieved significantly better than their rural counterparts.

CONCLUSION

Based on the findings of the study, it is hereby concluded that of the three instructional strategies investigated, mastery learning strategy is the most effective in facilitating students' achievement in Chemistry. Also, gender and school location had no statistically significant influence on students' academic achievement.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

- Chemistry teachers should adopt mastery learning strategy in teaching chemistry.
- Curriculum planners should ensure the incorporation of mastery learning in teaching chemistry.
- Government in conjunction with professional bodies like STAN should endeavor to organize and sponsor regular workshops to train chemistry teachers on the use of mastery learning strategy.
- Government agencies should sponsor further research on the efficiency of mastery learning and other innovative learning strategies in enhancing students' achievement in Chemistry.

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