



## Impacts of Mastery- Learning Approach on Performance in Threshold Concepts in Chemistry Among Secondary School Students in Kano Municipal, Nigeria.

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### Abstract

This study investigated the impacts of mastery-learning approach (MLA) on performance in threshold concepts in Chemistry among senior secondary school students in Kano municipal, Kano State, Nigeria. A pretest, posttest test nonequivalent group Quasi-experimental research design was used for the study which featured two groups (Experimental and Control). A sample size of 204 students was selected from four Senior Secondary Schools in Kano Municipal, drawn from a population of 37 schools with a total population of 3126 students. The Instrument used for data collection was; Threshold Concept Performance Test (TCPT) which used a reliability estimate of 0.80. Two research questions and two null hypotheses guided the research. The data collected were analyzed using Mean, Standard deviation and t-test statistics. Some of the major findings from the study are: there is significant difference in the mean performance scores of chemistry students taught Threshold Concepts with MLA, in Chemistry (Enthalpy) compared to their counterparts taught using Conventional teaching method. However, gender have no influence on academic performance. Based on the findings, it was recommended among others, that Chemistry teachers should incorporate into main stream pedagogy in the teaching of chemistry at Senior Secondary Schools the use of MLA to improve students' academic performance of learned concepts in chemistry.

**Keyword:** Mastery-Learning approach, Performance, Conventional teaching method, Threshold concepts.

### Introduction

In this present age of science and technology when scientific knowledge has grown exponentially, technological innovations have progressed at a rapid pace, and the effects of science and technology are clearly witnessed in all aspects of life. It is obvious that science and technology play a key role in the future of societies (Aydoğdu, 2006). The British Science Council (2009) defined science as the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. Okeke (2007) defined technology as the process of devising and utilizing techniques to convert resources to material objects. One of the science subjects is Chemistry. Ababio, (2004) defined chemistry as the branch of science that deals with the composition, properties, and uses of matter. Chemistry probes into the principles governing the changes that matter undergoes. Ojokuku, 2012, opined that Chemistry's importance in this modern world cannot be left out whether in the area of transportation, communication, security, banking, healthcare or entertainment; they all rely on science and technology in one way or another. Chemistry education should be emphasized at the secondary school in terms of teaching and learning as it plays a vital role in unifying other science subjects. The study of chemistry is essential for Nigeria's

scientific and technological development (Nwagbo & Chikelu, 2011). According to Jegede, (2010) Chemistry is everywhere, Chemistry is life. Despite the key role of chemistry as the central science that forms the basic foundation to many disciplines and in improving the quality of life, the performance of Nigerian secondary senior school students in Chemistry has for many years remained a matter of a serious concern.

In view of this, it becomes incumbent on science educators at all levels to search on how best to stimulate effective teaching and learning processes by the use of appropriate instructional strategies. Kochar, (2007) opined that the best of the curriculum and the most perfect syllabus of any programme or course of study remain dead unless quickened into life by appropriate instructional strategies, effective, dedicated and competent hands (teachers). Wood and Gentile (2003) posited that there are better ways to learn than through the traditional methods. Many of the standard methods of conveying knowledge have been shown to be relatively ineffective in the student's ability to master and then retain important concepts. The traditional methods (lecture, laboratory, recitation), as opined by, Wood and Gentile, (2003) do not tend to foster critical thinking, creative thinking and collaborative problem-solving. Looking at the abstract nature of some chemistry concepts, it makes it

imperative to focus on classroom instructions or teaching methods that will change the students' perspectives and develop students' interest in chemistry concepts. The teaching and learning of chemistry demand that the teacher uses more than one teaching approach, as cited by Akanbi and Opasina (2002) who stated that teaching is a dynamic process of bringing learners into an active productive contact with the stimuli of learning. There are several instructional strategies which teachers can adopt in helping students to achieve greater heights in their academic pursuit, one of which is the Mastery-Learning Approach (MLA). Bloom, (1968) suggested that all or almost all students can master what they are taught and also provide a compact and interesting way of increasing likelihood that more students will attain a satisfactory level of performance in school subjects. Mastery-Learning Approach (MLA) involves breaking down the subject matter to be learned into units of learning, each with its own objectives.

Mastery-Learning Approach (MLA) is an instructional method, where students are allowed unlimited opportunities to demonstrate mastery of Content taught. Guskey (2007) reported that Bloom hypothesized that a classroom with Mastery-Learning as opposed to the traditional form of instruction would reduce the achievement gaps between varying groups of students. In Mastery-Learning, "the students are helped to master each learning unit before proceeding to a more advanced learning task" in contrast to "conventional instruction" (Bloom, 1971). From the foregoing, it should be noted that Mastery-Learning Approach focuses on students reaching a pre-determined level of mastering a unit before moving to another. Though MLA is as old as mankind it seems its application in the classroom seems to be forgotten, which makes the study necessary to ginger its importance.

Chemistry has a lot of abstract and difficult concepts. Studies of Davies and Mangan, (2010) stipulates that in every area of chemistry there are some ideas that many students find difficult to grasp, understanding these concepts can only be done by understanding some other concepts which are pre-requisites to them. For example, if we consider enthalpy as a threshold concept, it requires an appropriate combination of other concepts such as internal energy, pressure, volume, proportional relationships and energy transfers to open the Stargate portal, which, once passed through, leads to a transformed understanding of chemical reactions with respect to activation

energy, explanations of exothermic and endothermic reactions and quantitative explanations of chemical and enthalpy changes. Such difficult but key ideas have been recently termed Threshold Concepts by Meyer and Land, (2006). The term Threshold Concept (TC) refers to content of a discipline or profession that poses deep challenges to the learner (and the teaching of which this framework is meant to support).

However, Threshold Concepts are based on the premise that some concepts are 'troublesome' but once understood, lead to a deeper, more connected understanding of the concepts being taught. Threshold Concepts are recognized as a gateway or portal that leads the learner to a previously undiscovered and perhaps inaccessible, way of thinking (Meyer and Land, 2003). Threshold Concepts are those key ideas, concepts or processes in a discipline that need to be understood by students before they can understand other parts of the subject that follow from them. (Meyer and Land 2003). Meyer and Land (2003) defined a Threshold Concept as a concept that is core to understanding the subject, seismic as 'getting it' brings about a significant shift in perception of the subject. The idea of Threshold Concepts is useful, as it helps teachers to identify very important areas that are vital to help students understand.

Evidence has been provided that teachers reflect on their knowledge when preparing to teach using threshold concepts. In a recent study Park, (2015) reveals the identification of seven threshold concepts identified by high school teachers in Korea: 'mole, ideal gas law, periodic table, structure of an atom, electron configuration, orbital, chemical bond, and chemical equilibrium'. This has an impact on their pedagogical content knowledge development. Ngai, Sevia and Talanquer, (2014) reviewed the research finding regarding students' misconceptions in chemistry and listed six crosscutting disciplinary concepts that could be pivotal in assisting the integration of knowledge in chemistry: 'chemical identity, structure-property relationships, chemical causality, chemical mechanism, chemical control, and benefits-costs-risks'. Mastery of a concept often allows the learner to make connections that were up to that time hidden from view, making such students perform better academically.

Academic performance as defined by Usman (2000) is the measure of students learning or acquisition of certain skills at the end of teaching and learning activities. Academic performance refers to a student's success in meeting short or long- term goals in

education or a person's strong performance in a given academic arena.

In light of this, science educators need to seek suitable ways of tackling the current mass failure in science subject, if they are to halt the drifts of students from science subjects to Arts and Social Science subjects (WAEC Reports, 2018), as the goal for any teaching and learning process amongst others should be for a positive result, and that brings us to the need for more student involvement in classroom teaching and learning. Poor performance recorded in chemistry could be attributed to the teaching methods which do not allow students to demonstrate their abilities or skills according to their readiness level and learning needs. This study therefore investigated Impacts of Mastery-Learning Approach on Performance in Threshold Concepts in Chemistry among Secondary school students in Kano Municipal, Nigeria

Gender has remained a burning issue and has also remained relevant in education because it has been linked to performance and participation in certain professions (Sotonade, 2004). Some instructional strategies are gender biased while some are gender friendly; however, the degree of gender related differences in learning vary from one method to the other. Therefore, the impacts of Mastery-Learning Approach (MLA) on students' academic achievement and gender differences would be determined.

Research in chemistry education has continued to seek for better approaches to teaching chemistry in order to bring about meaningful learning by involving the students in the activity of learning and to identify factors responsible for low conceptual understanding in chemistry among secondary school students.

Studies done in Nigeria by Oludipe and Awokoya, 2010; Ameh and Dantani, 2012; Opara and Waswa, 2013 and Muhammad, 2014 observed that teachers are in a hurry and tend to rush through the scheme of work to enable them cover the topics in the curriculum within the given period, thereby making mastery of the subject not possible.

In promoting greater performance, studies like, Udo and Udofia (2014), Mitee and Obaitan (2015) Lamidi, Oyelekan and Olorundare (2015), reported that, Mastery- Learning Approach enhances academic performance. Therefore, this study investigated the Impacts of Mastery-Learning Approach on Performance in Threshold Concept in Chemistry among Senior Secondary School Students, in Kano Municipal, Nigeria.

Based on the problem of the study, the following were the specific objectives for the study

1. To determine the effect of MLA on students' performance in threshold concepts in chemistry.
2. To investigate the effect of MLA on male and female students' performance in threshold concepts in chemistry

In line with the purpose of the study, the following research questions guided the study:

1. what are the academic performance mean scores of senior secondary school students taught threshold concepts using Mastery-Learning Approach and those taught the same concepts using Conventional Teaching Method?
2. what are the academic performance mean scores of male and female students taught threshold concepts using Mastery-Learning Approach

The following hypotheses were formulated in line with the research questions and were tested at 0.05 level of significance.

**HO<sub>1</sub>** There is no significant difference in academic performance means scores of senior secondary school students taught threshold concepts using Mastery-Learning Approach and those taught same concepts using Conventional Teaching Method.

**HO<sub>2</sub>** There is no significant difference in the academic performance means scores of male and female students taught threshold concepts using Mastery-Learning Approach.

## Method

The study employed quasi-experimental design specifically a pretest, posttest non-equivalent control group design. The study was carried out at Kano municipal among SS 11 chemistry students, with a population of 3126 students, the sample size was 204 students and stratified random sampling technique was used. A pretest was administered to the sample selected in order to determine the equivalence of the sample in ability to ensure they are not significantly different before commencement of the treatment. The experimental group was taught using Mastery-Learning Approach for a period of six weeks. The control group was taught the same concept for six weeks. At the end of treatment period, a post test was

administered to both groups of students, in order to evaluate the impact of the treatment for enhancing the academic performance of threshold concepts in chemistry among secondary school chemistry students. An instrument, Threshold Concepts Performance Test (TCPT) was adapted by the researcher from WEAC question papers, were the structure of some questions were modified; the instrument was validated by lecturers at A.B.U. Zaria, F.C.E Zaria and a teacher in one of the science school in Kano municipal, Kano for both face and content validation for the purpose of generating data for the study. The reliability was carried out using split half method; a reliability estimate of 0.80 was used as computed using statistical package for social sciences (SPSS). It was aimed at testing students understanding of threshold concepts (enthalpy)

### Results

The results are present based on the research questions and hypotheses

For descriptive analysis, mean and standard deviation statistics was used to answer the research questions while for inferential analysis, analysis of co variance (ANCOVA) and t-test was used to test the null hypotheses at  $p \leq 0.05$  level of significance as follows;

To answer research question 1, the mean scores between the experimental and control group were determined using descriptive statistics and the result is presented in Table 1

**Table 1. Mean and Standard Deviation of performance scores of Students in Experimental and Control Groups**

Group	N	Mean	SD	MD
Experiment	73	15.05	3.56	1.22
Control	131	13.83	4.59	
Total	204			

Table 1. The table showed that the experimental group had a mean performance score of 15.05, while the control group had a mean performance score of 13.83, this shows that the students in the experimental group had a higher score with a mean difference of 1.22. so mastery learning enhances academic performance of the students in the experimental group therefore the higher mean score of the experimental group is attributed to the treatment administered.

**Table 2: Mean and Standard Deviation of performance scores of Male and Female Students in the Experimental Group**

Group	N	Mean	SD	MD
Males	33	14.45	2.87	1.10
Females	40	15.55	4.01	

The results in Table 2 showed that the male students had a mean score of 14.45 while their female counterparts had a mean score of 15.55. The female group had a higher score, with mean difference of 1.10, which is insignificant as it is a relatively small difference may be due to the fact that the same treatment was administered to the two groups, by the same researcher using the same method.

**Table 3: summary of ANCOVA analysis of mean performance scores of students in the Experiment (MLA) and control groups**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	125.672 <sup>a</sup>	4	31.418	1.791	.003
Intercept	2973.315	1	2973.315	164.335	.000
pretest	23.683	1	23.683	1.309	.254
Group(Treatment)	3648.616	3	3648.616	121.555	.002
Error	3600.499	199	18.093		
Total	45261.000	204			
Corrected Total	3722.172	203			

a. R Squared=0.033(Adjusted R Squared=0.13)

Table 3 shows the treatment, as main effect, had significant effect on students' performance in the chemistry threshold concept ( $F=121.555$ ,  $P=0.002<0.05$ ) the null hypothesis was therefore

rejected. It meant that significant difference existed in the mean performance scores of students taught with mastery learning approach and those taught with conventional teaching method.



**Table 4: Summary of t-test Analysis of Performance Scores of Male and Female Students in Experimental Group.**

Sex	N	Mean	SD	df	P-Value	Remarks
Males	33	14.45	2.87	71	0.19	*NS
Females	40	15.55	4.01			
Total	73					

Where NS=Not Significant,  $p > 0.05$

From Table 4. t-test statistics showed that there is no significant difference in the posttest scores of male and female chemistry students' taught threshold concepts using Mastery-Learning Approach. The p-value of 0.19 at degree of freedom of 71 which is greater than  $p \leq 0.05$  alpha values. Therefore, the null hypothesis two which states that there are no significant differences in the performance mean scores between male and female students taught threshold concepts using Mastery-Learning Approach is hereby retained.

### Discussion

Findings of this study revealed better performance of students exposed to Mastery- Learning Approach compared to those students taught using Conventional Teaching Method. Agreed with earlier findings of Udo and Udofia, (2014) Lamidi, Oyelekan and Olorundare, (2015) which indicated that students taught chemistry concepts using Mastery-Learning Approach performed better than those taught using Conventional Teaching Method.

The superiority of Mastery-Learning Approach arises from the fact that students were given initial instructions on the topic, then grouped to have further discussions on the topic, a formative assessment was then individually given which was then marked and detailed positive feedback of the assessment was given to the students, these were those who mastered the topic continued with the enrichment activities and those who are yet to master it were given parallel formative assessment till they mastered it and all moved to the next topic. This discussion by the groups and positive feedback along with enrichment/parallel assessment enhanced meaningful learning of the whole lesson as such produced a positive learning outcome. This was why significant difference exists and a better performance was observed on students taught using Mastery- Learning Approach than those taught using Conventional Teaching Method.

Findings also showed no significant difference in the performance of male and female students taught threshold concepts using Mastery-Learning

Approach. Results showed that MLA does not differentiate the academic performance of both male and female students taught threshold concepts. The gender equality among students in threshold concepts in Kano Municipal was due to the fact that MLA allows both male and female students in the various experimental groups to actually discuss their topics to other members in the group and take on individual assessment at the end of the topic. Therefore, promotes their understanding of the concept, enhances their performance and bridged the gap between performance of male and female students. In this research there was no difference in academic performance in male and female students due to the fact that they were exposed to same concepts, by the same teacher using the same method of instruction; therefore, Mastery Learning Approach is gender friendly.

This finding is in line with that of Lamidi, Oyelekan and Olorundare, (2015) who found out that there is no gender difference in the academic performance of male and female secondary school students exposed to MLA. The finding is however in disagreement with that of Udo and Udofia, (2014) which reported that gender had a significant influence on the students with the males performing better than their females 'counterparts when Mastery-Learning Approach was used.

### Conclusion

As a result of the findings in this study, it can be concluded that: Mastery - Learning Approach improves the academic performance of threshold concepts of secondary school students.

1. The male and female students' performances were observed to have no significant difference when taught threshold concepts using Mastery-Learning Approach.
2. Meaning that Mastery-Learning Approach was found to be gender-friendly.

## Recommendations

On the basis of the findings, the following recommendations are made;

1. The use of Mastery - Learning Approach is appropriate in improving the performance of students in senior secondary schools Threshold concepts. It should therefore, be incorporated into the main stream of pedagogy in the teaching of chemistry and other science subjects at senior secondary schools in Nigerian secondary schools.
2. Science Teachers Association of Nigeria (STAN) and Chemical Society of Nigeria (CSN) should organize workshops on Mastery-Learning Approach. This will ensure the development of its knowledge in the teachers on training.

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