



Effects of Mastery Learning and Problem Solving Approaches (Kainuwa et.al. 2021)

## Effects of Mastery Learning and Problem Solving Approaches on Achievement in Mathematics among Secondary School Students in Gusau, Zamfara State

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### Abstract

The crux of this paper was to examine the effects of mastery learning and problem solving approach on achievement in mathematics among secondary school students in Gusau, Zamfara State, Nigeria. Quasi-experimental research design was used for the study. Four secondary schools were randomly selected and assigned to experimental and control groups. A total of four hundred and fifty (450) male and female students were used for the study. Data was collected using a 25- item Mathematics Achievement Test (MAT) made up of topics perceived as difficult topics. The instrument was pilot tested and Kuder Richardson formula 21 (KR21) was used to establish the reliability coefficient ( $r = 0.83$ ). Pre-test was administered to both the experimental and control groups to ascertain if the two groups were comparable and have the same entry characteristics before the treatment. A post-test was administered to both groups after two weeks of exposing the experimental group to mastery learning and problem solving methods and the control group to traditional/ conventional (lecture) method. Data collected was analysed using descriptive statistics and Analysis of Variance (ANOVA). The result indicated that there is a significant difference in mathematics academic achievement between male and female senior secondary school students in Gusau, Zamfara State. The result indicated that there is significant difference in mathematics academic achievement between senior secondary school students taught using MLA, those taught using PSA and those taught using Conventional Approach in Gusau, Zamfara State. Hence the two approaches were recommended as the most efficient of the teaching methods.

**Keywords:** Mastery Learning Approach Problem Solving Approach, Academic Achievement, Senior Secondary School Students



## **Introduction**

This study focuses on the effects of mastery learning approach and problem solving approach on academic achievement of female secondary school students in Gusau, Zamfara state. Teaching is said to be a complex problem-solving activity which involves the transmission of right values, skills and knowledge between at least two individuals that is, the teacher and the learner (Adeniji et.al. 2018). According to Abimbola (2009), teaching involves giving instruction to somebody on knowledge, skills and attitudes with the intention that the person will be able to act in a particular way that is compatible with the instruction. Teaching is associated with various responsibilities such as transmitting appropriate knowledge, developing individuals to cultivate good habits, creating awareness in order to appreciate national goals and developing individuals who can survive and compete globally. Teaching and learning are done in respective subjects so that students could pass both internal and external examinations distinctively. However, in mathematics, students' performances have not been satisfactory as demonstrated by educational stakeholders. This was confirmed by the West African Examinations Council (WAEC) Chief Examiners' report of 2014 and 2015 where candidates who had credit and above are 61.97% and 65.94%, respectively. Furthermore, it was expressed by the report that candidates do not perform well in some aspect of mathematics which may contribute to their low performance in the subject. The Nigerian Mathematics curriculum is student centered; it emphasizes learning developmental needs and interest (Adedayo, 2006). However, evidence shows that student's cognitive and affective domains in Mathematics especially female students fall below expectation (WAEC Chief Examiner 2012-2016). Stake holders have been making concerted efforts to ensure that these problems which are attributed to poor performances are detected through critical examination of students' selection of questions at terminal examinations (SSCE/NECO).

Mathematics is a basic tool in the development of any science-based knowledge for sound analytical reasoning in daily living in a modern society such as ours (Babalola, 1998). The Nigerian government quite desirous of achieving scientific and technological independence tried to introduce a number of innovations aimed at encouraging the learning of science in schools. As the nation is geared towards technological advancement, Mathematics as a vital subject has a role to play. It is therefore, expedient that Mathematics teachers know what to teach, when and how to teach it, and why female students are having difficulty in passing Mathematics examinations as well as how to stimulate interest in the subject. Hence, students need to be motivated to study effectively in order to achieve success (Usman, 2002).

It has been observed that students like avoiding questions in some particular topics during examinations. There is need to identify some of the topics students fail/avoid and which teachers deliberately skip while teaching so that corrective measures can be taken. Some topics which are referred as perceived difficult/skipped are those students take as complex and cannot be easily solved. Adeleke (2007) conducted a study on topics preference of senior secondary students in Mathematics. She discovered that numbers and numerations, algebraic process and statistics were the most preferred topics while bearing and distances, probability and mensuration were the most disliked topics. Nnaji (1988) in another study found out that some topics which students perceived as difficult; namely: longitude and latitude, bearings and distances, probability, two-variables inequality, change of subject formula, arithmetic and geometry (sequence and series), number bases, graphs (linear and quadratic types) and set theory are the major difficult topics for the students.



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Mastery Learning Approach (MLA) is an instructional method, where students are allowed unlimited opportunities to demonstrate mastery of Content taught. MLA involves breaking down the subject matter to be learned into units of learning, each with its own objectives. Guskey (2007) reported that Bloom hypothesized that a classroom with a mastery learning focus 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" (Bloom 1968, 1971) in contrast to "conventional instruction". Mastery learning uses differentiated and individualized instruction, progress monitoring, formative assessment, feedback, corrective procedures, and instructional alignment to minimize achievement gaps.

Problem solving is recognized as an important life skill involving a range of processes including analyzing, interpreting, and reasoning, predicting, evaluating and reflecting. For that reason educating students as efficient problem solvers is an important role of mathematics education. Problem solving skill is the centre of mathematics curriculum. Students' gaining of that skill in school mathematics is closely related with the learning environment to be formed and the roles given to the student (Ikaratas & baki, 2013).s.

In this study, Polya problem-solving model was used; Polya's (1957) four-step process has provided a model for the teaching and assessing problem solving in mathematics classrooms: understanding the problem, devising a plan, carrying out the plan, and looking back. Polya (1957) problem-solving model stated that an instructor/teacher need to understand a problem, devise a plan for solving the problem, carryout the plan successfully and look back to find out that the problem has been resolved (Polya, 2014). He identified these as the four phases required in solving Mathematics problems. Polya identified problem solving as a major problem in the teaching/learning of mathematics. A problem is a difficult issue or event, which has to be solved. It is an issue which is completely new to an individual and to which he/she has no ready-made response or method of solution. Solving a problem therefore means findings a way out of a difficult situation that is unique to the problem solved:

1. Incomplete understanding of the problem owing to lack of concentration;
2. Rushing into calculations without any plans or ideas;
3. In carrying out the plans the most frequent faults are impatience and failure to read through the work

The principles in Polya's phases problem solving was applied by the researcher in providing solutions in the teaching/learning of some of the perceived difficult concept in senior secondary mathematics syllabus such as Arithmetic and Geometric Progressions, Circle Geometry, Geometrical Constructions, Probability, Bearing and Distances etc.

Gender is found to have impact on students' preference in Mathematics topics. This finding corroborates the view of Sadker and Sadker (1994a) that sitting in the same classroom, reading the same textbook, listening to the same teacher, boys and girls perceive things in different ways. The findings also support the position of Honey, Moeller, Brunner, Bennett, Clements and Hawkins (1991) that females and Males perceived Mathematics related topics in distinct manners. Many male students are found to prefer Number and Numeration, Algebra Process, Mensuration and Construction while many female students prefer plane Geometry. Preference could be traced to the activities male and female students usually engage in at home. Most male students most often engage in games that demand the use of four basic Mathematical rules. Female students on the other hand make use of various objects at home and this



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may have influence on their preference for plane geometry and other related topics. Gender according to Aremu (2001) may have been known to influence school achievement. Studies by Reap and Cavallo (1992), Chamber and Andre (1997) and Jegede and Inyang (1990) supported the findings that gender differences predict academic achievement in favour of male students.

Nonetheless there is research which concludes that gender does not affect attitudes towards mathematics (Georgiou, et.al. 2007; Mohamed & Waheed, 2011). In the same vein, the meta-analysis conducted by Ma & Kishor (1997) which looks at 113 studies (n=55265), when studying the effects of gender, concludes that this variable did not have a significant effect on the relationships between attitudes and performance in mathematics because separate analysis by gender demonstrated similar significant effect sizes. Georgiou et al. (2007) showed that there was no difference either in mathematics achievement or in mathematics attitudes between boys and girls. However, high achieving boys and girls, despite both considering mathematics as an attractive subject, differed in the explanations they gave for their performance. Since the ability attributions of boys were higher, they believed that their grades were due to their intelligence more consistently than girls did.

Over the years, there have been consistent poor performances and high failure rates in Senior Certificate Examinations in almost all the subjects in Zamfara State. This is evident in the daily complaints from state Government, Local Government Education Authorities (LGEA), Parent Teachers Associations (PTA), Individual Parents, Teachers and Community. The General of the poor performances in the SSCE is also echoed daily in the States print and electronic media houses. Many students perform poorly in mathematics due to one reason or the other; thereby limiting their career to progress further in their areas of interest. This is because many institutions of higher learning as well as professional bodies insist on a minimum credit pass in Mathematics for admission or employment.

The Chief examiners report 2007-2016 analysis of SSCE results showed that averagely only a small proportion of candidates passed Mathematics at credit level throughout the examination period in Zamfara State. Table 1 shows statistics performance in mathematics for WAEC/SSCE examination results for Zamfara state from 2007 – 2016.

**Table 1: Statistics Performance in Mathematics for WAEC/SSCE Examination Results for Zamfara State from 2007 – 2016**

Year	Total no of candidate who sat for SSCE		Total no of candidates who passed with credit level (1-6)		Percentage passed		Percentage failure	
	Male	Female	Male	Female	Male	Female	Male	Female
2007	8486	2000	2402	586	28.31	29.30	71.70	70.70
2008	9100	2486	2301	543	26.28	5.96	74.71	94.03
2009	10484	3100	3542	356	33.79	3.40	66.21	96.60
2010	12655	3210	3820	604	25.36	4.77	74.64	95.22
2011	14571	3300	2182	589	14.47	4.04	85.02	95.96
2012	20047	5000	5322	489	26.54	9.78	73.45	90.22
2013	20872	4000	3218	209	15.42	5.22	84.58	94.78
2014	20188	5000	5899	704	29.22	14.08	70.78	85.92
2015	18047	4000	4693	482	26.00	12.05	73.99	87.95
2016	19165	4300	5963	598	31.12	13.90	68.88	86.09



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Table 1 shows the statistics Performance in Mathematics for WAEC/SSCE Examination in Zamfara State from 2007 – 2016. This analysis shows that averagely only a small proportion of the candidates passed mathematics at credit level and above. The overall performance of students in WASSCE examination nationwide in 2014 regarded as the best result for the past ten years in Nigeria. Zamfara State recorded an average performance of 6.66% in Mathematics and English Language. This is indeed worrisome and urgent intervention is needed to remedy this situation. Among the reasons identified by the Chief examiners 2007-2016 for the poor performance are:

1. Failure to apply correctly source Mathematical principles
2. Inability to work to the required degree of accuracy
3. Lack of basic manipulative skills
4. Inability to visualize the component part of 3 – dimensional objects
5. Lack of required skills in geometrical construction among others.

Moreover, mathematics is one of the compulsory subjects at secondary schools in Nigeria (FRN, 2013); but students' performance in the subject has not been satisfactory. Teachers' use of inappropriate instructional strategies was said to be one of the identified causes of unsatisfactory performance (Salman et al., 2012) in mathematics especially female secondary schools of Zamfara state. Aside this, several factors can influence the performance of students in mathematics some of which are gender, attitude, scoring levels and learning styles. Researchers have been carried out their research on the effect of mastery learning approach on students' academic performance in mathematics and science. Abakpa and Iji (2013); Akinsola (2007); Kazu, et al. (2008); Udo & Udofia (2014); and Zakariyya et al. (2016) in different studies reported that mastery learning approach improved students' performances. Although, none of these studies examined the effects of mastery learning approach and problem solving approach on academic achievement of female secondary school students. Also, these studies were not carried out in Gusau, Zamfara State and female secondary school students was not the sample used.

The present study, therefore, compares the academic achievement of female secondary school students taught using mastery learning approach and problem solving approach and those taught conventionally. Also, the influence of gender and scoring levels on students' performance were examined because there was no conclusive result in literature. Even though the approaches are popular but some of the teachers are not aware of MLA and PSA as such they are not utilising them always. While it has been acknowledged that mastery learning and problem solving approaches could enhance students' performance in some subjects and topics as observed in literature, the study deem it fit to investigate whether the position could be extended to teaching of mathematics. Therefore, urgent and appropriate remediation is needed to reduce this massive failure thereby making the subject interesting to the students. This can be done by finding appropriate solution to areas or topics that students perceive difficult which the re-occurring topics in SSCE are causing massive failure in the subject.

### **Objectives of the study**

The objectives of the research are as follows

1. To determine differences in Mathematics Academic Achievement between Male and Female Senior Secondary School Students in Gusau, Zamfara State.





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2. To determine difference in Mathematics Academic Achievement between senior secondary school students taught using MLA, those taught using PSA and those taught using Conventional Approach in Gusau, Zamfara State.

**Research Hypotheses**

The following hypotheses were stated to guide the study:

1. There will be no significant difference in mathematics academic achievement between male and female senior secondary school students in Gusau, Zamfara State.
2. There will be no significant difference in Mathematics Academic Achievement between senior secondary school students taught using MLA, those taught using PSA and those taught using Conventional Approach in Gusau, Zamfara State.

**Methodology**

The study adopted quasi-experimental pre-test/ post-test control group design (Campbell & Stanley, 1963). The study was carried out in Gusau city. The findings in this paper are drawn from a research study on the use of mastery learning and problem solving methods in the teaching and learning of some perceived difficult concepts in mathematics among senior secondary school students in Zamfara State. The target population for the study is the entire senior secondary school students of Gusau city. Four hundred and fifty students (450) were selected by the use of stratified random sampling. The sample for the study also consists of 150 students for Mastery Learning, 150 students for Problem Solving and 150 students for Conventional Approach all comprising of males and female students. There were three groups made up of two treatments and one control group. One group was taught with mastery learning, the other with problem solving method while the control group was taught with conventional method. Data was collected using a 25-item Mathematics Achievement Test (MAT) covering the concept of probability perceived as one of the difficult topics drawn from past WAEC questions. All the 25 items were objective questions instructing the students to circle the correct answer to the question.

The researchers adopted the instrument which was a 25-item multiple choice objective tests, it has been compiled and prepared by the researchers from the past Mathematics question papers of WAEC/NECO for years (2007-2016) covering the concept of probability and statistics regarded as perceived difficult topic. Although, there was no need for further validation of the questions, it has a high stability coefficient of 0.97 at 0.05 level of significant when tested during the pilot study. The items covered only the topic studied during the experimental period. The instrument was pilot tested and Kuder Richardson formula 21 (KR21) was used to establish the reliability coefficient ( $r = 0.83$ ). Even though, the instrument was adopted from the past Mathematics question papers of WAEC/NECO for years (2007-2016) it is extremely important to subject the instruments to a validation process; one approach commonly used with the instruments is to give copies to panel of experts for validation (Ujo Lopes, & de Alencar, 2000). In this study, experts in measurement and evaluation, research methodology and English language were used in validating the instruments. The experts comprised of three professors and two PhD lecturers. Pre-test was administered to both the experimental and control groups to ascertain if the two groups are comparable and have the same entry characteristics before the treatment. A post-test was administered to both groups after two weeks of exposing the experimental group to mastery learning and problem solving methods and the control group to conventional (Lecture) teaching method. Data collected were analysed using descriptive statistics and Analysis of Variance (ANOVA).



## Results

### Hypothesis One

There will be no significant difference in mathematics academic achievement between male and female senior secondary school students in Gusau, Zamfara State.

**Table 2: T-Test showing Significant Difference across Gender**

		Levene's Equality of F	Test for Sig.	for T-test Means t	Equality of df	Sig. (2- tailed)
Mathematics Achievement Test for Male Students	Equal Variance Assumed	.367	.545	.076	448	.940
Mathematics Achievement Test for Female Students	Equal Variances no Assumed			.076	447.597	.940

**Level of Significance < 0.05; df = 448; t-cal = 0.76; t-tab = 0.94**

From table 2, it is evident that the t-cal (0.076) is less than the t-tab (0.940), a situation where we accept the null hypothesis which means that there is no significant difference in mathematics academic achievement between male and female senior secondary school students in Gusau, Zamfara State..

### Hypothesis Two

There will be no significant difference in Mathematics Academic Achievement between senior secondary school students taught using MLA, those taught using PSA and those taught using conventional approach in Gusau, Zamfara state.

**Table 3: Significant Difference between Post-test scores in Mathematics Achievement Test (MAT)**

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1723.098	2	861.549	23.205	.000
Within Group	16596.227	447	37.128	.4043	
Control	150	9.0809	4.9229	.4019	
Total	450	10.1200	5.5269	.2605	

**P < 0.05; df = 2 and 447; f-tab = 0.00 and f-cal = 23.205, significant**

Referring to the decision rule for the f-test where we reject the null hypothesis when the f-cal is greater than the f-tab and accept the alternative hypothesis, which is the case obtainable in the above analysis. Hence, we reject the null hypothesis and accept the alternative hypothesis which states that there is significant difference between the experimental group and the Control group in the post-test scores of students' attitude. A confirmatory test to show the significant between the pairs of groups using Scheffes Multiple Comparison test was carried out shown on Table 4.



**Table 4: The Scheffes Multiple Comparison Test**

		Mean Difference (I-J)	Std. Error	Sig.
(I) Type of Treatment	(J) Types of Treatment			
MLA	PSA	2.9867	.7036	.000
	Control	4.7400	.7036	
PSA	MLA	-2.9867	.7036	.000
	Control	1.7533	.7036	.046
Control	MLA	-4.7400	.7036	.000
	PSA	-1.7533	.7036	.046

The result on table 4 shows that there is significant difference between all the pairs that is MLA and PSA, MLA and Control, PSA and Control. With the Mastery learning having the greatest mean score; hence recommended as the most efficient of the teaching methods.

### Discussion on Findings

In hypothesis 1, it was found that there was no significant difference in mathematics academic achievement between male and female senior secondary school students in Gusau, Zamfara State in the post-test scores of Students mathematics academic achievement test. This finding is contradicting earlier study by Sadker and Sadker, (1994a), Jegede and Inyang (1990), Aremu (2001) which supported the findings that gender differences predict academic achievement in favour of male students'.

Nonetheless, it corroborates with the research which concludes that gender does not affect mathematics academic achievement (Georgiou,Stavrinides, &Kalavana 2007,Mohamed &Waheed, 2011).In the same vein, the meta-analysis conducted by Ma & Kishor (1997) which looks at 113 studies (n=55265), when studying the effects of gender, concludes that this variable did not have a significant effect on the relationships on mathematics academic achievement because separate analysis by gender demonstrated similar significant effect sizes. Georgiou et al. (2007) showed that there was no difference either in mathematics achievement or in mathematics attitudes between boys and girls. However, high achieving boys and girls, despite both considering mathematics as an attractive subject, differed in the explanations they gave for their performance. Since the ability attributions of boys were higher, they believed that their grades were due to their intelligence more consistently than girls did.

Hypothesis 2 showed that there was a significant difference between the experimental groups and the control in the post-test scores of mathematics achievement test. It was further discovered that the treatments given to the experimental groups must have been better than the control group who received placebo (lecture method). This finding is in support of earlier study by Babalola (1983), Frazer (1982) and Dayle (1983) who used mastery learning and problem-solving approaches in teaching mathematics and obtained favourable result in students' performance. This is also a plausible reason why the researchers embarked on this study having studied the efficacy of the mastery learning and problem-solving approaches in the teaching and learning of mathematics.





## Conclusion

The present study concludes that there is no difference between male and female students in Mathematics Achievement Test and Mastery Learning Approach (MLA) and Problem Solving Approach (PSA) are more effective in enhancing Mathematics Achievement than conventional approach. It was discovered that the treatment given to the groups were efficacious thus the researchers recorded significant improvement in mathematics performance among the treatment groups.

## Recommendations

Based on the findings of the study, it was recommended that:

1. Since the findings of this research showed no gender effect in mathematics achievement test, male and female students should be accorded the same opportunity in the classroom.
2. Classroom teachers should adopt mastery learning and problem-solving techniques in the teaching and learning of difficult concepts in mathematics.

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