Effect of Mastery Learning Approach on Senior Secondary School Students’ Achievement in Geometry

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Abstract
This study examined the effect of mastery learning approach (MLA) on senior secondary school students’ achievement in geometry. Five research questions and five hypotheses were asked and formulated respectively. Non-randomised pre-test post-test control group design was used. A sample of 270 out of 855 students from three out of 26 secondary schools in Makurdi was used for the study. Instrument of data collection was Geometry Achievement Test (GAT). It has a reliability index of 0.72 for section A and 0.84 using Kuder –Richardson K-R20 and Kendall’s W respectively. Research questions were answered with means and standard deviations while Analysis of Covariance was used to test the hypotheses. Results show that mastery learning approach improved students’ achievement in geometry. Also, it was found that MLA narrowed the gap between students with high and low ability in geometry. Furthermore, male and female students improved equally in geometry achievement test. It was recommended that teachers should be encouraged to integrate MLA in their classrooms.

Introduction
Teaching and learning of mathematics consistently generates interest among scholars over the years. This is because of the importance of mathematics to the humanity. Mathematics is an intellectually stimulating subject that affects every facet of human activity such as politics, economy, science and technology. Salman (2005) described it as a precursor of scientific discoveries and inventions. The learning of mathematics has become imperative in every society if the citizens are to cope with the fast changing development in science and technology. The importance of mathematics to man may account for its inclusion in school curriculum as a compulsory subject for every child of school age to acquire the appropriate mathematical skills that will enable him cope with life challenges.

Despite the relevance of mathematics in national development, analysis of school certificate mathematics examination results show that students’ have consistently low as less than 42% of registered candidates obtain credit pass (Uwadie, 2010). Chief Examiner’s report on students’ areas of deficiency in school certificate examinations showed that students least understood geometry concepts as shown by their achievement (WAEC, 2007). Most students avoid geometry questions or haphazardly attempt them. Research reports indicated that many reasons account for students’ poor achievement in geometry. Among these are poor teaching approach (WAEC, 2007, Olunloye,2010), lack of confidence in the subject(Basturk and Yavuz,2010),
In a heterogeneous class where students of different abilities are taught together, only a few of the students achieve high scores in achievement test. According to Olunloye (2010), this ugly trend of high failure rate in mathematics is a national disaster. This, therefore, calls for mathematics educators to intensify efforts in research to proffer solution that will ameliorate the situation.

Instructional approach employed by teachers is one of the most important areas that researchers have put their searchlight. This is because it can easily be manipulated to bring positive changes in learners than other factors like gender, ability and intelligence. According to Olunloye (2010), teachers should improve their teaching methods in order to enhance better understanding and application of geometry among the students so that their interest could be aroused. Thus, there is need to explore approaches that will improve students’ achievement as current results (WAEC, 2010) indicate that the conventional teaching approach is deficient in meeting the needs of majority of learners. The conventional teaching approach is described as teacher centred and didactic with learners simply listening, copying notes, doing class work and doing assignments. Furthermore, with conventional teaching approach (CTA), gap between high and low ability students is very wide.

Besides differences in achievement between high and low ability students, gender difference is often reported in mathematics achievement test. Vale (2009), Abiam and Odok (2006) reported that gender differences in mathematics achievement exist but that it is reducing over the years. Analysing the WAEC result of 2008, Uwaidiae (2008) reported that 7.32% and 6.42% of male and female students respectively obtained credit pass. Specifically, Abiam and Odok (2006) found that there is no significant relationship between gender and achievement in number and numeration, statistics, algebra but a weak relationship between gender and achievement in geometry and trigonometry. Also, Amelink (2009) indicated that male students performed better in geometry and measurement among eight graders, while numbers and operations were better performed by female students. Thus, the review showed that male students achieved higher scores in geometry than the female students. Thus, there is need for more studies on instructional strategies that can enhance equal achievement among the gender in geometry which necessitates this study.

Teachers have the potential of exerting strong influence on students’ learning. Uloko and Usman (2008) reported that there is a positive correlation between good teaching approach and students’ achievement in mathematics. Also, Iji (2005) stated that good strategy improves both low and high ability students in geometry at the upper basic education class. That is good teaching approach produces high achievement among learners while poor teaching approach will lead to poor learning and low achievement. This was what necessitated the researchers to examine the efficacy of mastery learning approach (MLA) in the
Mastery learning is an instructional approach that is anchored on behavioural learning theory which believes that learning is determined by the experiences that learners are exposed to within the environment (Bruce, 1970). According to Goliath (2007), proponents of mastery learning such as Keller and Bloom affirmed that under appropriate instructional conditions, learners will learn and benefit maximally from the instruction. Thus, mastery learning is based on the assumption that if instruction is good, qualitative and appropriate learners will learn well and achieve high when learning time is varied according to learners’ pace.

In MLA classes, learners are expected to master the learning objectives to specified criteria in a unit before proceeding to the next unit. All learners who could not obtain marks up to the criteria set are subjected to further remedial lessons and parallel tests until 75% of them master at least 75% of the objectives of a unit before proceeding to the next unit. By this approach, it is believed that individual difference between learners will be minimized at the end of instruction. MLA in this study involves providing: quality instruction, immediate feedback to learners, corrective lessons for remediation, and re-testing until the set criteria for mastery was achieved. Yildrin Adyin (2005), Aderemi (2006), Akinsola(2007) and Kazu, Kazu and Ozedemi (2008) from their respective studies found that MLA improved students’ achievement in mathematics and sciences. Thus, will MLA help to improve both high and low ability students’ achievement in geometry? Again, will gap in gender differences in geometry achievement test be narrowed if MLA is adopted by mathematics teachers?

Purpose of the Study
The main purpose of this study is to determine the effect of MLA in teaching and learning of geometry in senior secondary school. The specific objectives of this study are to:

i. Determine the effect of MLA on students’ achievement in geometry;

ii. Determine the effect of MLA on students’ achievement in geometry according to ability;

iii. Examine the effect of MLA on students’ achievement in geometry according to gender;

iv. Determine the interaction effect of teaching approach on students’ ability; and

v. Determine the interaction effect of teaching approach on gender.

Research Questions
The following research questions provided a guide to this study:
2. What is the effect of MLA on the mean achievement scores of students in geometry?
3. What is the effect of MLA on mean geometry achievement scores of different ability groups (low and high)?
4. What is the interaction effect of approach and ability on students’ achievement in geometry?
5. What is the interaction effect of approach and gender on students’ achievement in geometry?

Hypotheses
The following research hypotheses were formulated and tested at 0.05 level of significance:

H01: There is no significant difference between the mean achievement scores of students taught geometry using mastery learning approach and conventional teaching approach.

H02: There is no significant difference between the mean achievement scores of students of different ability levels taught geometry using mastery learning approach.

H03: There is no significant difference between the mean achievement scores of male and female students taught geometry using mastery learning approach.

H04: There is no interaction effect between approach and ability levels on students’ mean achievement scores in geometry.

H05: The interaction effect of gender and approach on the mean achievement scores of students in geometry is not significant.

Method
The study employed a quasi experimental design of non-equivalent design of non-equivalent pre-test post-test control group design. Intact classes were used to avoid disrupting school programmes for experimental purpose. A sample of 270 out of 850 SS1 students from three out of 26 senior secondary schools in Makurdi Metropolis in Benue State was used. Multi-stage sampling technique was adopted in order to fulfill the criteria for selection. First criterion was to select schools with mathematics teachers who obtained B.Ed or B.Sc (Ed) degree teaching the SS1 classes. Secondly, secondary schools that had at least two streams and have presented students for school certificate in the last ten years. Twelve schools met these conditions. Thus, one school each from eight co-educational, two boys only and two girls’ only schools was selected. From each school selected, a class with two or more streams was further selected for the
Since intact classes were used, the entire students of each selected stream were used for the study. However, where there were more than two streams, simple random sampling was used to select the classes using the hat-draw method. Simple random sampling was adopted for co-educational schools since one school was to be selected out of eight such schools using the hat-draw method. Again, purposive sampling technique was used to select one school each for the boys and girls only. The choice of which of the two schools in each school type to be selected was done by a flip of a coin. Finally, allocation of streams into experimental and control groups was done by the flip of coin. All the streams that chose head or tail became control and experimental groups respectively. This was merely for the convenience of the researcher.

The students in both experimental and control groups were taught the same topics using the same instructional materials to minimize Hawthorne effect. Also, the same test items administered to students in the experimental group were given to those in control group as assignments in order to avoid inter-group competition. Finally, to reduce students’ interaction effect, the workbooks of students in experimental group was retained by their teacher during the experiment.

The research instrument was Geometry Achievement Test (GAT) constructed by the researchers. Initially, GAT consisted of 50 multiple choice items of four options and 15 theory test items were given to three mathematics educators and two mathematics teachers in the secondary schools for validation. Their corrections and suggestions resulted in the 50 items with two sections. Section A is 40 multiple choice test items while section B is an essay-type of ten items. GAT and the marking schemes were validated by three mathematics educators and two. The topics taught during the study comprised: (i) length of arcs and areas of sectors; (ii), surface area of simple solids; (iii), surface area of compound solids; and (iv), volume of solids. The items were trial tested on thirty students in a school different from those used for the study. The reliability of section A(multiple choice items) was computed using Kuder-Richardson K-R20 while section B (essay items) was with Kendall tau inter-rater reliability coefficient which were respectively scored dichotomously and non-dichotomously. Thus, the reliability coefficients of GAT were 0.72 for section A and 0.84 for section B. GAT was administered as pre-test. The result of pre-test was used to classify the students into low and high ability using the fiftieth percentile score. Four teachers were engaged to teach for five weeks using the prepared lesson plans a day after the pre-test. One of the teachers who was introduced as a new teacher taught the experimental group in each school while the three regular teachers taught the control group in their
The results of the study are presented according to the questions asked and their corresponding hypotheses.

Research question 1:
What is the effect of MLA on the mean achievement scores of students in geometry?

The result is presented in Table 1. The result indicates that the control group had a mean achievement score of 11.81 and a standard deviation of 7.84 in pre-GAT while the experimental group had a mean and standard deviation of 10.21 and 6.48 respectively in pre-GAT. Similarly, in post-GAT, the mean achievement score and standard deviation of the control group are 19.92 and 9.37 respectively while the mean achievement score and standard deviation of the experimental group are 32.17 and 7.81 respectively. The mean difference between pre-GAT and post-GAT for the control and experimental groups are 8.11 and 21.96 respectively. This implies that students taught geometry using MLA improved in GAT than those taught with CTA.

Table 1: Mean Achievement Scores, Standard Deviations and Adjusted Mean Scores of the Experimental and Control Groups in Geometry Achievement Tests

<table>
<thead>
<tr>
<th>Teaching Approach</th>
<th>Pre-GAT</th>
<th>Post-GAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Control</td>
<td>11.81</td>
<td>7.84</td>
</tr>
<tr>
<td>Experimental</td>
<td>10.21</td>
<td>6.48</td>
</tr>
<tr>
<td>Total</td>
<td>270</td>
<td></td>
</tr>
</tbody>
</table>

H01: There is no significant difference between the mean achievement scores of students of different ability levels taught geometry using mastery learning approach.

The ANCOVA statistic was computed as shown in Table 2.
Table 2 shows that the main effect, teaching approach, has F-calculated value of 586.046 and it is greater than the table value of 3.84 at 0.05 level of significance. This is based on 1-degree of freedom for numerator and 267 degree of freedom for denominator. Thus, the null hypothesis is rejected. This implies that students’ geometry achievement scores in experimental group is statistically significant to those in the control group.

Research Question 2
What is the effect of MLA on mean geometry achievement scores of different ability groups (low and high)?

Table 3: Mean Scores, Standard Deviations And Mean Differences of Mastery Learning Approach in GAT According to Ability Levels.

<table>
<thead>
<tr>
<th>Type of Tests</th>
<th>Ability Levels</th>
<th>Mean Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-GAT</td>
<td>10.15</td>
<td>5.76</td>
</tr>
<tr>
<td>Post-GAT</td>
<td>32.44</td>
<td>7.21</td>
</tr>
<tr>
<td>Mean Diff.</td>
<td>22.29</td>
<td>21.63</td>
</tr>
</tbody>
</table>

From table 3, the result shows that difference between Pre-GAT and Post-GAT mean achievement scores of low and high ability students in control group are 7.18 and 8.82 respectively. Also from table 3, the difference between mean achievement scores of students with low and high ability in Pre-GAT from post-GAT in experimental group are 21.63 and 22.69 respectively. This shows that both low and high ability students taught using MLA improved in post-GAT scores.

H02: There is no significant difference between the mean achievement scores of students of different ability levels taught geometry using mastery learning approach.
The result is presented in table 4.

Table 4: Summary of Two-Way Analysis of Covariance of the Experimental ups on Achievement due to Ability and Sex

<table>
<thead>
<tr>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Squares</th>
<th>F_{cal}</th>
<th>Decision at P &lt; 0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>6521.947</td>
<td>5</td>
<td>1304.388</td>
<td>105.332</td>
<td>Significant</td>
</tr>
<tr>
<td>Intercept</td>
<td>15607.499</td>
<td>1</td>
<td>15607.499</td>
<td>1260.332</td>
<td>Significant</td>
</tr>
<tr>
<td>Approach</td>
<td>5890.085</td>
<td>1</td>
<td>5890.085</td>
<td>475.835</td>
<td>Significant</td>
</tr>
<tr>
<td>Ability</td>
<td>6.219</td>
<td>1</td>
<td>6.219</td>
<td>0.502</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Sex</td>
<td>0.514</td>
<td>1</td>
<td>0.514</td>
<td>0.042</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Ability*Approach</td>
<td>0.332</td>
<td>1</td>
<td>0.332</td>
<td>0.027</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Sex*Approach</td>
<td>8.172</td>
<td>1</td>
<td>8.172</td>
<td>0.660</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Error</td>
<td>1595.105</td>
<td>128</td>
<td>8.172</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>146799.000</td>
<td>134</td>
<td>12.384</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>8107.052</td>
<td>133</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 shows that the main effect, ability, has F-calculated value of 0.502 which is less than the table value of 3.84. This means that the null hypothesis is accepted. That is, the difference in mean achievement scores of high and low ability students taught geometry using mastery learning approach is not statistically significant.

Research Question 3
What is the effect of MLA on mean achievement scores of male and female students in geometry?

The result is presented in table 4.

Table 5: Mean Achievement Scores and Standard Deviations of Male and Female Students of Experimental Groups in Geometry Achievement Tests

<table>
<thead>
<tr>
<th>TEST TYPE</th>
<th>SEX</th>
<th>MALE</th>
<th>SD</th>
<th>FEMALE</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-GAT</td>
<td>Mean</td>
<td>9.264</td>
<td>5.511</td>
<td>11.306</td>
<td>7.341</td>
</tr>
<tr>
<td>Post-GAT</td>
<td>Mean</td>
<td>31.604</td>
<td>7.302</td>
<td>32.172</td>
<td>7.807</td>
</tr>
<tr>
<td>Diff Mean.</td>
<td>Mean</td>
<td>22.340</td>
<td>20.866</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From Table 5, the difference between the mean achievement scores of male and female are 22.23 and 20.866 respectively. This indicates that both male and female students improved upon their mean scores in the post-GAT. The test of associated hypothesis is presented in hypothesis 3.

**HO₃**: There is no significant difference between the mean achievement scores of male and female students taught geometry using mastery learning approach.

From Table 4, F-calculated is 0.042 which is less than the table value of 3.84. The null hypothesis is therefore, accepted. That is, the difference in mean achievement scores between male and female students taught geometry with MLA is not statistically significant.

**Discussion**

The result of this study revealed that students taught geometry during this study with MLA improved in their achievement scores than those in CTA group. This result is consistent with the findings of Awotunde and Bot(2003), Yildrin and Adyin (2005), Aderemi (2006) and Kazu, Kazu and Ozedemi (2008) who found that mastery learning if effectively employed would improve students’ achievement in a given task. This implies that MLA enhances higher scores in geometry achievement test than CTA which is deficient in meeting learners’ needs. Furthermore, the result shows that MLA improved the achievement scores of both male and female students in post-GAT. The non significant difference in the mean achievement scores is an indication that MLA minimises gender difference. This disagrees with findings of Abiam and Odok (2006), Akinsola(2007), Eng, Li and Julaihi (2009), and Vale(2009) who reported that female students are weaker in geometry area of mathematics than the male students. On the other hand, the result agrees with the report of Vale (2009) and Achor, Imoko and Ajai(2010) who stated that there is no gender difference when good teaching method is used.

Again, the findings of this showed that MLA influences both low and high ability students to achieve high in geometry as students at both levels improved their scores and no significant difference in their mean scores. This also confirms the reports of Iji (2005), Usman and Uloko (2008) who found that an effective teaching method bridges the gap between the low and high achieving students. Thus, MLA is effective in influencing students of different abilities to equally achieve high in a learning task.

**Recommendations**

On the basis of findings from this study, it is recommended that:

- Secondary school mathematics teachers should be encouraged to explore the application of MLA in their classroom instruction as the task is enormous.
Teacher trainers should integrate MLA among instructional strategies being inculcated into the students.

- Seminars and workshops should be organised for serving teachers to keep abreast with principles and implementation process of MLA.
- More teachers should be recruited to reduce class size as the current large class size may hinder effective implementation of the MLA as an instructional strategy.

Conclusion
Teaching strategy from reviews has the potential to make or mar students’ achievement. MLA is found to improve students’ achievement in geometry than CTA. Furthermore, MLA helped to bridge gaps between male and female students as well as students with low and high ability.

Reference


