Enhancing Mathematics Achievement of Secondary School Students Using Mastery Learning Approach

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Abstract
The perennial problem of poor performance of students in Mathematics has remained a matter of great concern to all. Despite the introduction and implementation of different teaching methods/strategies suggested by researchers, the achievements of students in mathematics have persistently been poor, hence the need to explore different instructional approaches. The purpose of this study therefore is to investigate the effect of Mastery Learning Approach on Secondary School students’ achievement in mathematics. The design of the study is quasi-experimental, utilizing pretest posttest non-equivalent group. A sample of 150 SS1 students was drawn from three (3) Secondary Schools in Umuahia Education Zone of Abia State. Two experimental groups namely Mastery Learning and Collaborative Mastery Learning and a Control Group were each constituted in the three Schools. Data were collected using Mathematics Achievement Test validated by experts and found to have a reliability index of 0.87. Results of data analyses done using mean, standard deviation and ANCOVA indicate that Mastery Learning Approach enhances students’ achievement in Mathematics. Results also show that Mastery Learning Approach bridges the gap between students with high and low abilities in Mathematics. However, no significant difference was found in the mean achievements of students in the two experimental groups. The researcher concludes that mastery learning approach to instruction is capable of enhancing mathematics achievement of both high and low ability students. This finding no doubt will inform the teacher of the need to accommodate individual differences in learners, tailor instruction to individual needs of the learners and wait patiently to insure mastery. By so doing, students will be motivated to learn. The paper recommends that Mathematics teachers should be encouraged to integrate Mastery Learning Approach in their instructions, and that curriculum planners should include a variety of teaching strategies that will accommodate both fast and slow learners in the curriculum.

Keywords: mastery learning, collaborative mastery learning, high and low abilities, mathematics achievement.

INTRODUCTION
Mathematics is one of the subjects that is taken very seriously in the school system, irrespective of country or level of education. It has been described as a model of thinking (Iji, 2008), which encourages learners to observe, reflect and reason logically about a problem and in communicating ideas, making it the central intellectual discipline and a vital tool in science, commerce and technology (Imoko and Agwagah, 2006). In the words of Salman (2005), mathematics is a precursor of scientific discoveries and inventions. It is the foundation for any meaningful scientific endeavour and any nation that must develop in science and technology must have a strong mathematical foundation for its youths.

In terms of curriculum relevance, mathematics is compulsory at the secondary school level and a prerequisite for moving from the junior to the senior secondary school; just as at the tertiary level of education, a sound background in mathematics is a necessary condition for the study of all science, technology and social science based courses, as required by the joint admission and matriculation board (JAMB).

Despite the recognition accorded to mathematics due to its relevance, Elekwa (2010) remarked that students exhibit non-chalant attitude towards mathematics, even when they know that they need it to forge ahead in their studies and in life. Such students who have already conditioned their minds that mathematics is a difficult subject are usually not serious in the learning of mathematics and therefore perform poorly in mathematics tests and examination. Analysis of school certificate mathematics examination results shows that students’ performances in mathematics are consistently poor. Uwadie, (2010) reported that less than 42% of registered candidate in SSCE obtain credit pass in mathematics. Even the SSCE results released by WAEC and NECO for 2012 indicated poor achievement of students in mathematics.

According to Olunloye (2010), this ugly trend of high failure rate in mathematics is a national disaster. Therefore, feasible ways of improving the
performance has remained an area of great concern for researchers. The deplorable state of mathematics achievement is attributed to a number of factors such as attitude of students (Uhumuavbi and Umoren, 2005); lack of instructional resources (Yara and Otieno, 2010); Instructional techniques (Olutonye, 2010) among others. Although many factors affect a student’s mathematics learning and achievement, one factor over which schools have the most immediate control is the choice of mathematics program to be implemented by teachers, administrators and curriculum developers. Instructional technique adopted by the teacher can be manipulated to bring about improvement in performance of students. Hence teaching and learning of mathematics consistently generates interest among scholars over the years. Several studies have shown that good instructional strategies are capable of improving the achievement of students in mathematics and other subjects (Iji, 2005; Iheninnu, 2008).

According to WAEC (2010), current results show that the conventional teaching approach is deficient in meeting the needs of majority of learners. The present practice of mechanically applying the same methods to dull, average as well as the bright children could be responsible for much of the ineffectiveness of instruction given in schools. In the classroom, instructions are prepared with the average students in focus. The above average of fast learners feel bored whereas slow learners or below average students remain passive and day by day they become poor in the subject. Research evidences show that failure of large magnitude, high drop-out and stagnation rate etc. may occur because of accumulated learning deficit brought about by non-insistence on mastery of materials learnt at each of the earlier stages. What is imperative then is an innovative proposal for change, a significant department from current practice, a redirection of education for this country.

One option is mastery learning. Mastery learning (Block and Anderson, 1975) is an approach to learning intended to bring all students to a pre-established level of mastery on a set of instructional objectives. Students are taught to well-defined objectives, formatively assessed, given corrective instruction if needed, and then summatively assessed. This model provides teachers with timely feedback about the progress and deficiencies of students in meeting specific instructional goals and presents a curriculum that provides extra time and opportunities for all students to attain mastery. This learning approach takes care of individual differences in learning, due to individual student’s characteristics as well as their aspirations. Mastery learning as an instructional strategy is based on the principle that all the students can learn a set of reasonable objectives with appropriate instruction and sufficient time to learn.

In mastery learning classes, students are not advanced to a subsequent learning objective until they demonstrate proficiency with the current one. Students must demonstrate mastery on unit examinations, typically 80%, before moving onto new material (Davis and Sorrell, 1995). Students who do not achieve mastery receive remediation through tutoring, peer monitoring, small group discussions, or additional homework. Additional time for learning is prescribed for those requiring remediation.

Mastery learning instructional approach is based on behavioural learning theory. Behaviourists believe that learning is influenced by the experiences that learners are exposed to within the environment. Mastery learning is especially necessary in mathematics. Mathematical concepts are hierarchically organized such that failure to learn prerequisite skills is likely to interfere with students’ learning of later skills. In mathematics, concepts are inter-related and inter-woven and any student who fails to master the pre-requisite to a particular topic may not be able to master the topic. Overmayer (2010) stated that the challenge of covering the entire mathematics syllabus while accommodating the needs of struggling students creates an almost impossible situation. Consequently, many students move through the mathematical curriculum with deficiencies. Students stumble through the mathematics curriculum with these gaps in learning, gaps that seem to grow exponentially, until finally, frustrated by continuous failure, many drop out, he added.

Some scholars have studied the efficacy of mastery learning as an instructional strategy. Samuel (2007), Wambugu and Changeiywo (2008), Olunfumilayo (2010) and Akinsola (2011) in their respective studies reported that MLA is effective in improving the achievement of students in the sciences. Similarly, Abakpa & Iji (2011) and Awofala & Nneji (2012) also reported that MLA enhanced students’ achievement in mathematics in Markurdi (Benue State) and Ibadan (Oyo State) respectively.

Collaborative learning strategy refers to any instructional method in which students walk together in groups for the purpose of achieving a common academic goal. Dillenbourg (1999) broadly defined collaborative learning as “a situation in which two or more people learn or attempt to learn something together. Collaborative learning centres mostly on students’ joint exploration or application of the course material rather than the traditional teacher’s presentation and explanation of the abstract concept that make up mathematical knowledge.

Instructional situation involves students of different ability levels. Hence heterogynous groups comprising high and low ability students can be formed in
classroom environment for collaboration. Scholars are interested on the effect of instructional method or strategy on ability groups. Iji (2005) stated that good teaching strategy enhances both the high and low ability students in geometry at the upper basic education class. Also Elekwa (2010) reported that collaborative teaching and learning strategy improves the performance of both high and low ability students in mathematics. These results corroborate that of Akinsola (2011) who studied the relative effectiveness of mastery learning cooperative learning and combined mastery learning and cooperative learning strategy on students’ achievement in integrated science by ability and gender and reported no significant main effect of ability on student’s achievement in integrated science.

From the review of studies in mastery learning as show in literature, it was observed that most existing works in mastery learning were conducted in other geographical regions other than Abia state. To fill this gap, this work which investigates the efficacy of mastery learning approach to instruction in enhancing the mathematics achievement of secondary school students was conducted in Abia State of Nigeria. The study also explores the efficiency of mastery learning approaches in bridging the gap between high and low ability students’ achievement in mathematics.

STATEMENT OF PROBLEM
The purpose of the study is to evaluate the extent to which mastery learning instructional approaches enhances mathematics achievement of students of different ability levels.

PURPOSE OF THE STUDY
The purpose of the study is to explore the effect of mastery learning approaches on students’ achievement in mathematics. Specifically, the study is designed to:
1. Investigate the differences in the mathematics achievement of students who used mastery learning approach and those who used the conventional teaching approach.
2. Compare the achievement of students in group1 (mastery learning) and group2 (collaborative mastery learning)
3. Compare the achievement of high and low ability students who are exposed to mastery learning approaches.

RESEARCH QUESTIONS
1. What is the effect of mastery learning approaches on achievement of students in mathematics?
2. To what extent does the achievement of students in the two mastery learning groups differ?
3. To what extent could mastery learning approaches enhance the performance of high and low ability students in mathematics?

HYPOTHESES
The following null hypotheses were formulated and tested at 0.05 level of significance.

H01: There is no significant difference in the mean achievement scores of students in the experimental groups and control group.
H02: There is no significant difference in the mean achievement scores of students in the two mastery learning groups
H03: There is no significant difference in the mean achievement scores of high and low ability students exposed to mastery learning methods.

METHODOLOGY
The quasi-experimental pre-test post-test, non-equivalent control group design was adopted for the study. Randomly selected groups instead of randomly composed samples were used. Intact classes were used in order not to disrupt normal school program during the experiment. Two experimental groups namely mastery learning and collaborative mastery learning and one control group were constituted for the study. A sample of 150 senior secondary classes one (ss1) students were selected from 1235 ss1 students in three schools chosen from Umuahia Education Zone of Abia state.

Purposive or judgmental (non-probability sampling) was used to select the local government area and the schools for the experiment. Simple random sampling and area or cluster sampling was used to select the classes for the experiment. Any student belonging to the chosen streams or classes automatically becomes a subject for the experiment. Furthermore, balloting was used to assign each of the selected classes to experimental and control groups.

The instrument for the study is Mathematics Achievement Test (MAT). The researcher constructed 50 multiple choice test items of 4 options and 5 essay questions for pre-test. Similarly, 40 multiple choice test items and 10 essay questions were constructed for post-test. The MAT and the marking guide were validated by four mathematics teachers. The instruments were administered to a sample of 30 ss2 students who had studied the topics for the experiment on two occasions with 14 days interval. These students were drawn from a co-educational school situated in the same area but not used as one of the schools for experiment. The scores of the 30 students in objective test items were analysed using Cronbach Alpha to determine the internal consistency of the items and reliability co-
efficient of 0.96 was obtained. Copies of the scripts of the 30 students were photocopied and scored by the researcher and two other mathematics teachers. The scores awarded by the raters were analysed using kendall’s coefficient of Concordance (w) to measure the degree of agreement among the raters. A reliability coefficient of 0.93 was obtained for the essay questions. Pearson Product Moment Correlation Coefficient was used to determine the stability of the instrument in the test re-tests and a coefficient of 0.87 was obtained.

EXPERIMENTAL PROCEDURE

The experiment lasted for 6 weeks. The regular mathematics teachers of the schools selected for the study were coordinated and trained as research assistants to help in conducting the experiment. The teachers took up the groups to which their schools have been randomly assigned to. Students in the experimental group 1 received the conventional method of teaching mathematics. Prior to the commencement of the experiment, students in all the groups were administered pre-test at the same time. The result of the pre-test was used to locate the differential effectiveness of the teaching mathematics.

Data collected from the pre-test and post-test scores of the 150 students were analysed to answer the research questions and test the hypotheses. The research questions raised were answered using mean and standard deviation whereas the hypotheses formulated were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. Post hoc comparison of adjusted mean was employed to locate the differential effectiveness of the experimental groups.

RESULTS

Results of the study are presented according to research questions raised and their corresponding hypotheses

Research Question 1

How do mastery learning approaches affect the achievement of students in mathematics?

Table 1: Mean Achievement and Gain Scores of Experimental and Control Groups.

<table>
<thead>
<tr>
<th>Teaching approach</th>
<th>Pre-test Mean</th>
<th>Post-test Mean</th>
<th>Mean difference /Gain score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>32.76</td>
<td>64.34</td>
<td>31.38</td>
</tr>
<tr>
<td>Group 2</td>
<td>30.94</td>
<td>64.12</td>
<td>33.18</td>
</tr>
<tr>
<td>Group 3</td>
<td>33.68</td>
<td>34.26</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Source: Computed using achievement scores of experimental and control groups.

From the Table 1 above, the experimental groups 1 and 2 had a gain score of 31.38 and 33.18 while the control group had a gain score of 0.58. This suggests that mastery learning approaches affected the performance of students in mathematics positively. A formal test of hypothesis was done to determine whether these differences are statistically significant.

Hypothesis 1:
There is no significant difference in the mean achievement scores of the students in the experimental groups and control groups.

Table 2: Analysis of covariance of performance of students by treatment

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>d.f.</th>
<th>Mean square</th>
<th>F value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected model</td>
<td>48569.79</td>
<td>3</td>
<td>16189.931</td>
<td>196.005</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>29919.203</td>
<td>1</td>
<td>29919.203</td>
<td>362.219</td>
<td>.000</td>
</tr>
<tr>
<td>method</td>
<td>18628.552</td>
<td>1</td>
<td>18628.552</td>
<td>225.528</td>
<td>.000</td>
</tr>
<tr>
<td>Error</td>
<td>32321.360</td>
<td>2</td>
<td>16160.680</td>
<td>195.650</td>
<td>.000</td>
</tr>
<tr>
<td>Total Corrected</td>
<td>60629.360</td>
<td>4</td>
<td>15157.325</td>
<td>195.650</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. R square = .801 (Adjusted R squared = .797)

Source: Computed using achievement scores of experimental and control groups.

The results on Table 2 indicate an F-ratio value of 195.65 which is statistically significant at the 0.05 level. We reject the null hypothesis and conclude that there is significant difference in the performance of students in the three groups; students in group 1&2 outperformed their counterparts in group 3. Hence mastery learning approaches enhanced the achievement of students in mathematics.

Research Question 2:
To what extent does the achievement of students in the two mastery learning groups differ?

From Table 1 above, the gain scores of 31.38 for mastery learning group 1 is less than the gain score of collaborative mastery learning (33.18). This shows that collaborative mastery learning affected the mathematics achievement of students more than mastery learning approach only.
Hypothesis 2:
There is no significant difference in the mean achievement scores of students in the two mastery learning groups.

Table 3: Summary of Analysis of Covariance of pairwise comparison of group 1 and 2

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>d.f.</th>
<th>Mean square</th>
<th>F-cal</th>
<th>Probability(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast</td>
<td>34,424</td>
<td>1</td>
<td>34,424</td>
<td>0.417</td>
<td>0.520</td>
</tr>
<tr>
<td>Error</td>
<td>120,596,568</td>
<td>146</td>
<td>82,600</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed using achievement scores of experimental and control groups.

The f-cal of 0.419 is not significant at 0.05 levels. The null hypothesis is therefore accepted. The conclusion is that there is no significant difference in the adjusted means of the two mastery learning groups.

Research Question 3:
To what extent could mastery learning approaches enhance the performance of high ability and how ability students in mathematics?

Table 4: Mean scores, standard deviations and Mean Differences of mastery learning Approaches in Maths Achievement Test according to Ability levels.

<table>
<thead>
<tr>
<th>Type of tests</th>
<th>Ability levels</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Low</td>
<td></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Pre-test</td>
<td>50.63</td>
<td>21.89</td>
<td>8.15</td>
<td>9.36</td>
<td></td>
</tr>
<tr>
<td>Post-test</td>
<td>76.29</td>
<td>57.74</td>
<td>8.17</td>
<td>10.84</td>
<td></td>
</tr>
<tr>
<td>Mean difference</td>
<td>25.66</td>
<td>35.85</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed using achievement scores of experimental groups.

From Table 4, the result shows that difference between pre and post mean achievement scores of high and low ability students in mastery learning are 25.66 and 35.85 respectively. This indicates that both high and low ability students taught using the MLAs improved in Mathematics Achievement. However students in low ability group have a higher gain score.

Hypothesis 3:
There is no significant difference in the mean achievement scores of high and low ability students taught mathematics using Mastery Learning Approaches.

Table 5: Analysis of Covariance of performance of high and low ability groups

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III sum of squares</th>
<th>d.f.</th>
<th>Mean square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected model</td>
<td>154,70.889*</td>
<td>2</td>
<td>773.544</td>
<td>350.491</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>548.2000</td>
<td>1</td>
<td>548.2000</td>
<td>248.388</td>
<td>.000</td>
</tr>
<tr>
<td>Pre-ability</td>
<td>764.875</td>
<td>1</td>
<td>764.875</td>
<td>346.387</td>
<td>.000</td>
</tr>
<tr>
<td>Ability</td>
<td>643.145</td>
<td>1</td>
<td>643.145</td>
<td>29.141</td>
<td>.000</td>
</tr>
<tr>
<td>Error</td>
<td>2140.821</td>
<td>97</td>
<td>22.070</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>43,016,000</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>17611.710</td>
<td>99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Source: Computed using achievement scores of experimental groups.

From Table 5, the f-ratio of 29.14 is statistically significant at 0.05. The null hypothesis is rejected. The implication is that the difference between the adjusted means of high and low ability groups is significant at 0.05. Hence although both levels benefitted from mastery learning, low ability students benefitted more than high ability students.

DISCUSSIONS
Results of the analysis of covariance showed significant difference in the adjusted mean scores of the groups (MLA, CMLA, and CT) in their academic achievement in mathematics. Students in the MLA and CMLA outperformed their counterparts in the control group. The result indicates that mastery learning strategy is effective in enhancing the performance of students in mathematics. The findings from this study corroborate those of other researchers (Samuel, 2007; Wambugu and Changeiwywo, 2008; Olunfunmilayo, 2010; Akinsola, 2011; and Abakpa and Iji, 2012) who reported that mastery learning if effectively employed would enhance students’ academic achievement in various school subjects.

The effectiveness of mastery learning approach could be due to the inherent advantage of the approach on insisting on attainment of mastery of unit objective before proceeding to the next topic. Hence the prerequisite to a topic is mastered well before studying the topic. The procedure of obtaining feedback on efficacy of instruction through continuous testing and retesting with other remediation is an added advantage of the approach. Hence students really understood the principles, concepts and formulae involved in the topics.

The finding that the post-test mean scores of the students in the MLA and CMLA did not differ significantly is contrary to the a priori expectation. It is expected that students in the CMLA who shared ideas in their areas of strengths and weaknesses will perform better than their counterparts in the other
experimental group. This finding indicates that attainment of mastery is based on individual conviction and determination. The students attained mastery of concepts on individual basis, since ML takes care of individual differences in learners due to individual student’s characteristics and aspirations.

Furthermore, the findings of this work show that mastery learning approaches positively affected both high and low ability students as both levels improved their gain scores. However, significant difference in their mean scores was established in favour of low ability students. The finding that low ability students benefited more than high ability students in mastery learning approach is not surprising. Mastery learning approach allowed the additional time and individual attention which the slow learners need to excel. These findings support the findings of Iji (2005) and Elekwa (2010) who reported that effective instructional strategies equally improved the performance of both high and low ability students. Thus, mastery learning approaches enhances the achievement of students of different abilities in a learning task.

**RECOMMENDATIONS**

Based on the findings of this study, the following recommendations are made.

- Mathematics teachers should be encouraged to adopt mastery learning approaches during instructions to foster students learning and retention of mathematics concepts.
- Educational planners should incorporate in the plans periods when the slow learners will be given additional instructions to ensure mastery and activities that will be used to keep the fast learners busy during such periods considering the fact that learners learn at different rates.
- Government need to motivate their teachers to encourage them put in their best to ensure that all students attain mastery of concept taught. Also, Government should recruit more qualified teachers to be able to cope with the increasing population of secondary school students.

**CONCLUSION**

Research evidence shows that instructional method or strategy influences academic achievement of students. Current results show that the conventional teaching approach is deficient in meeting the needs of majority of learners, hence the need to refocus attention on other alternative approaches. Mastery learning approach is found to be effective in enhancing the achievement of students in mathematics. It also helped to bridge the gap between high and low ability students.

**REFERENCES**


