Global Social Sciences Review (GSSR)
Vol. IV, **No.** IV (Fall 2019) | **Page:** 232 – 238

p-ISSN 2520-0348 | e-ISSN 2616-793X | L-ISSN 2616-793X | DOI: 10.31703/gssr.2019(IV-IV).30 | URL: http://dx.doi.org/10.31703/gssr.2019(IV-IV).30

Effects of Mastery Learning Model on Academic Achievement of Secondary School Students in Mathematics

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Abstract *The study aimed to investigate the effects of the Mastery Learning Model (MLM) on students' academic achievement in the subject of mathematics at secondary school level in the urban and rural areas of Mardan district, province Khyber Pakhtoonkhwa, Pakistan. It was a quasi-experimental study. The experimental design of the study was pre-test post-test non-equivalent group design. Two public schools from district Mardan were selected purposively. The students of grade 9th from these schools participated in this study. The number of participants was 214. Experimental groups were taught through MLM and control groups were exposed to the Conventional Method of Teaching (CMT). The instruments used for data collection were academic achievement tests. The data were analyzed through an independent sample t-test. The result declared that the performance of the students' experimental groups was better than those of the control groups. It was concluded that MLM enhanced academic achievement of students in urban and rural areas of district Mardan*

Key Words
Academic achievement; Conventional method of teaching; Mastery Learning Model; rural; urban.

Introduction

Education is of prime importance for the progress and development of a country. Today's world progress can't be thought without the progress in education. In the words of Arif (2010), it is "time tested reality that destiny of nations is shaped in classrooms as well as in social settings through education" (p. 19). The effectiveness of education in the classroom mainly depends upon the instructions of the teacher. It has been felt that modern techniques should be employed to ensure effective learning (Iqbal, 2004). The problem of selecting an appropriate method of teaching and its effects on students' achievement, particularly at the secondary school level is regarded as the most important in recent times (Lamidi, Oyelekan & Olorundare, 2015).

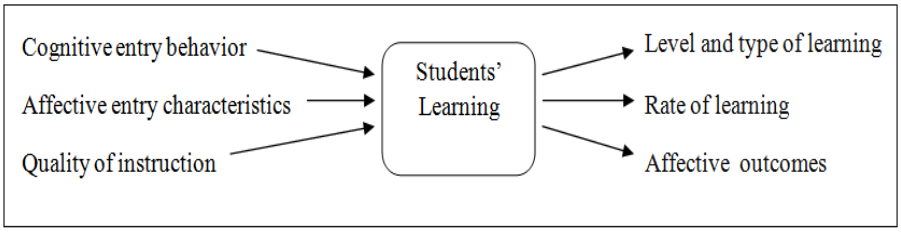
Over the years so many teaching approaches have been tested to improve the learning of students, but no one proved to be suitable for all the learners. The main reason is the individual differences that exist in a classroom (Bloom, 1968; Bloom, 1973; Block, 1971; Jegede, 2003). The students in a classroom have scattered capabilities, attitudes, interest and talents, so they learn at a different pace. It places a demand on teachers to plan and organize their instructions in such a way that they fulfill the needs of all students in a classroom.

Carrol (1963) worked on individual differences and presented the theoretical "Model of School Learning". Carrol believed that learning is the ratio between time spent and time needed. If every student is provided with enough time, and if the student spent that time appropriately, then s/he can attain mastery of the learning task. The degree of learning can be expressed as:

$$\text{Degree of learning} = f\left(\frac{\text{Time actually spent}}{\text{The time needed for learning}}\right)$$

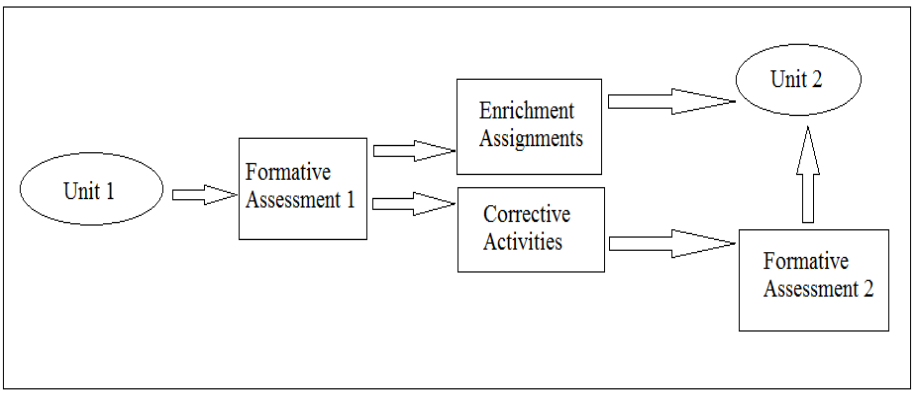
Benjamin Samuel Bloom worked on the theoretical "Model of School Learning" presented by Carroll and transformed into the practical model of learning and called it "Learning for Mastery". Bloom (1968) proposed that students would be provided with unlimited opportunities for learning and would not be preceded to the next concept until they master the prior concept. He presumed that every student can attain instructional objectives if the times are given for learning and instructional strategies are made appropriate to their characteristics (Bloom, 1976). His model supports the instructional

process systematically to address differences in learners (Shelton and Mason, 2014).Bloom (1976) pointed out three very important variables of mastery learning that determine learning outcomes. These are cognitive entry behavior (prerequisites for learning new tasks), affective entry characteristics (self-confidence, interest, attitude, and motivation for learning) and quality of instruction. These three variables are given in the figure below.



Variables of Mastery Learning

Mastery Learning emphasizes on the achievement of instructional objectives in each learning unit by all learners. The teacher first defines mastery for a particular task and then organizes a variety of group-based instructional techniques to fulfill the requirements of all students. Formative assessment with regular feedback and corrective assignments are used to ensure the achievement of learning objectives. Formative assessments are used to diagnose the weak areas and to improve the instructional process rather than to measure achievement. The criterion-referenced tests are used for the evaluation of students' performance rather than norm-referenced tests. Mastery learning Model is given in the figure below:



Mastery Learning Model

Since Bloom's presentation of the "Mastery Learning Model", extensive studies were conducted on mastery learning. Result of these studies proved mastery learning an effective strategy for classroom instructions.

Damavandi and Kashani (2010) conducted an experimental research study for the comparison of the effects of mastery learning method versus the conventional method on the performance and attitude of week students in chemistry. The result declared mastery learning a better approach as it enhanced the performance of those students in the said discipline and brought a positive change in their attitude. Nonye and Mgbemena (2012) reported better academic achievement by the senior secondary school students taught through a mastery learning approach. An enhanced academic achievement was exhibited by students in geometry under the effect of mastery learning when Abakpa and Iji (2013) compared mastery learning with conventional teaching. They also found that mastery learning minimized gender differences and learning variations in low and high ability students. Udo and Udofia (2014) compared the effects of Mastery Learning Strategy with the Conventional Lecture Method and found that mastery learning facilitated students' academic performance in various areas of the subject. Furo (2014) recorded higher academic achievement of experimental groups when learned through the Mastery Learning Approach. The researcher found that urban learners different from rural ones in terms of their learning outcomes. Lamidi, Oyelekan and Olorundare (2015) found that students exposed to Mastery Learning Strategy understood the concepts of chemistry more deeply. Hussain and Suleman (2016) tested the application of Mastery Learning in the subject of

English and found its positive impact on the learning outcomes of the learners. The research of Filgona, Filgona & Linus (2017) also revealed enhanced learning retention and improved learning outcomes in the academic discipline, namely Physical Geography by the senior secondary school students who were exposed to mastery learning strategy. Ejodamen and Raymond (2018) also reported better academic performance in basic technology by the learners taught through Mastery Learning Strategy.

Although a wide range of research reports existed on the topic; however available research indicated only a few studies at the national level. Further, no study existed to reveal the effects of Mastery Learning on students' academic achievements in the subject of mathematics in district Mardan. Therefore, the current investigation was carried out to fill the gaps in the realm of knowledge.

The current study aimed to explore the effects of MLM on the mathematics achievement of students at the secondary school level. Secondary school level is a milestone for higher and professional education and the subject of mathematics is taught as compulsory at this level. "The study of mathematics equips students with the skills to recognize relationships of different mathematical concepts with everyday situations, and to establish associations between mathematics and other subjects, thus develop the ability to extend and apply their mathematical knowledge in other fields of knowledge" (National Curriculum for Mathematics, 2006). Unfortunately, in Pakistan, the students of secondary classes do not show good results in the subject of mathematics which is evident from the gazette notifications of Secondary School Certificate Examinations. Researchers had documented the application of the conventional method as the main reason for low mathematics achievement at the secondary school level. To improve the academic performance of the students, it is indispensable to test student-centered teaching approaches in mathematics classrooms. Therefore, the researcher decided to examine the effects of MLM on secondary school students' academic achievement in the subject of mathematics.

Objectives of the study

The objectives of the study were:

1. To find out the effects of MLM on students' academic achievement in the urban areas of district Mardan.
2. To find out the effects of MLM on students' academic achievement in the rural areas of district Mardan.

Hypotheses of the study:

To attain the objectives of the study the following two null hypotheses were formulated:

$H_0$1 There is no significant difference in the academic achievement of urban students taught through MLM and taught through CMT.

$H_0$2 There is no significant difference in the academic achievement of rural students taught through MLM and taught through CMT.

Methodology

This was a quasi-experimental study that involved a comparison of MLM and CMT. The methodology of the study is given below:

Participants

The target population was all female students of 9th grade enrolled in public schools of district Mardan. There are a total 110 High and Higher Secondary Schools (female) in district Mardan. High Schools are 80 in number (5 Urban + 75 Rural), while Higher Secondary Schools are 30 (7 Urban + 23 Rural) (Government of Khyber Pakhtoonkhwa, 2018). Two government schools were selected purposively, one from an urban area and other from a rural area of district Mardan. From each school, two sections of grade 9th participated in this study. The total participants were 214. The natural setting of the classes was not disturbed, each section was taken as a group. The participants' distribution in different groups is given below.

- Experimental group (urban) = 48
- Control group (urban) = 48
- Experimental group (rural) = 59
- Control group (rural) = 59

Research Design

The research study was quasi-experimental. The research design was Pre-test post-test non- equivalent group design. The design is symbolically given below.

Pretest observation	Treatment	Posttest observations
O_1	X	O_3
O_2	C	O_4

Pre-test, post-test non-equivalent group design

O_1 and O_2 are Pre-test observations
O_3 and O_4 are Post Test observations And
O_1 and O_3 are experimental groups' observations
O_2 and O_4 are control groups' observations.

The dependent variable of the study was an academic achievement and independent variables were teaching methodologies.

Material and Procedure

The instruments used for data collection were:

1. Pretest
2. Post-test-1
3. Post-test-2

All instruments were developed by the researcher in collaboration with a subject specialist in mathematics and validated by mathematics experts in the Provincial Institute of Teacher Education (PITE). Each test was composed of 50 items.

Two chapters (chapter 4 and chapter 5) from grade 9th mathematics textbooks were selected to be taught during this study. Lesson plans were prepared by the researcher in collaboration with Subject Specialist (SS). These lesson plans were then validated by mathematics experts in the Regional Institute of Teacher Education (RITE) and PITE. Each lesson plan for experimental groups consisted of the following parts:

1. Introduction (information about the subject, teaching interval, methods to be adopted, and topic to be taught).
2. The objective of learning unite
3. Previous knowledge and its relation to the new topic
4. Presentation and explanation of the concept by the teacher
5. Students' activities (cooperative learning, peer tutoring, individual exercise, etc).
6. Formative assessment (first)
7. Feedback paired with corrective activities
8. Formative assessment (second/ third)
9. Enrichment activities
10. Assessment/Closure
11. Homework.

The lessons for control groups were planned following traditional lesson planning steps. Each lesson plan for control groups consisted of the following parts:

1. Introduction (consisted of information about the subject, teaching interval, methods and topic).
2. Objectives of the learning unite.
3. Presentation and explanation by the teacher.
4. Imitation and exercise by the students.
5. Homework.

One teacher from each school was selected to teach both groups in their respective schools. They were given two-week training in PITE to use MLM and CMT.

The pre-test was conducted at the beginning of the experimental period and data was collected. The pre-test served two purposes; 1) to determine prerequisite learning and, 2) to address equivalency problems. Experimental groups in both areas (urban and rural) were then exposed to MLM and control groups in both areas were taught through CMT. Post-test-1 was conducted at the completion of the first unit and at the completion of the second unit post-test-2 was administered to all the four groups. The duration of the experimental period was two months and twenty days.

Results

The independent sample t-test was applied to the collected data.

Table 1. A Comparison of pre-test means Achievement scores of Experimental and Control Groups.

Location	Groups	N	Df	Mean	SD	T-value	P-value
Urban	Exp group	48	94	17	7.58	.389	.698
	Cont group	48	93.99	17.6	7.63		
Rural	Exp group	59	116	13.29	9.20	0.634	0.527
	Cont group	59	115.30	14.41	9.95		

Table 1 revealed statistically no significant difference between the mean achievement scores of experimental and control groups. The difference in the mean scores of two groups of the urban area was 0.6 (17.6 -17) that was very small; and the p-value was .698 > .05, therefore not significant. Similarly, the difference in the mean scores of two groups of the rural area was 1.12 (14.41-13.29) and the p-value was 0.527 > 0.05, not significant. The data analysis revealed that in both areas the experimental and control groups were similar in academic performance, therefore, groups were measurable.

Table 2. Comparisons of Posttests' mean Achievement Scores of two Groups of the Urban Area

Test	Groups	N	Df	Mean	SD	T-value	P-value
Post-test-1	Exp group	48	94	34.87	6.80	6.419	.000*
	Cont group	48	84.99	24.02	9.54		
Post-test-2	Exp group	48	94	38.10	6.74	7.98	.000*
	Cont group	48	81.97	24.12	10.09		

Table 2 revealed significant differences between the mean achievement scores of two groups in post-test-1 and pot-test-2. At the post-test-1 stage, the difference in mean scores of experimental and control groups was 10.85 (34.87 – 24.02) and the p-value was .000 < 0.05, statistically significant. At the post-test-2 stage, the difference in mean scores of experimental and control groups was 13.98 (38.10 – 24.12) and the p-value was .000 < 0.05, therefore, statistically significant.

Testing hypothesis 1

$H_0$1: There is no significant difference in the academic achievement of urban students taught through MLM and taught through CMT.

The data analysis in table 2 revealed a statistically significant increase in the mean achievement scores of the experimental group after treatment. At post-test-1 stage the calculated t-value was 6.419 > 1.9855 (table value of t) and p-value was .000 < 0.05 (significant level); and at post-test-2 stage the calculated t-value was 7.98 > 1.9855 and p-value was .000 < 0.05. Therefore, the null hypothesis was rejected and the conclusion was drawn that MLM improved the academic achievement of urban students as compare to CMT.

Table 3. Comparisons of post-tests' mean achievement scores of two groups of rural area

Test	Groups	N	Df	Mean	SD	T-value	P-value
Post-test-1	Exp group	59	116	30.32	8.40	5.03	.000*
	Cont group	59	114.33	22.02	9.48		
Post-test-2	Exp group	59	116	39.58	8.48	10.04	.000*
	Cont group	59	113.738	22.66	9.77		

Table 3 revealed statistically significant differences between the mean achievement scores of experimental and control groups of rural areas in post-test-1 and pot-test-2. At the post-test-1 stage, the mean difference of experimental and control groups was 8.3 (30.32 – 22.02) and the p-value was .000 < 0.05, therefore significant. At post-test-2 stage the difference in mean scores was 16.92 (39.58 – 22.66) and p-value was .000 < 0.05, therefore statistically significant.

Testing hypothesis 2

$H_0$2: There is no significant difference in the academic achievement of rural students taught through MLM and taught through CMT.

The data analysis in table 3 showed a statistically significant increase in the mean achievement scores of the experimental group after treatment. At post-test-1 stage the calculated t-value was 5.03 > 1.9806 (tabulated value of t) and p-value was .000 < 0.05 (significant level); and at post-test-2 stage the calculated t-value was 10.04 > 1.9806 and p-value was .000 < 0.05. Therefore, the second null hypothesis was rejected and the conclusion was drawn that MLM improved the academic achievement of rural students as compare to CMT.

Discussion

The study aimed to explore the effects of MLM on students' academic achievement in the subject of mathematics. The design of the study was Pre-test post-test non-equivalent group design. The results declared that the groups exposed to MLM scored high on academic achievement tests as compared to their counter control groups. These results were in line with the results of Abakpa and Iji (2013); Ezinwanyi (2013); and Udo and Udofia (2014) who reported high academic achievement by students when exposed to mastery learning strategy. Damavandi and Kashani (2010) also found increased academic achievement by week students in the subject of chemistry when taught through mastery learning.

The findings of the study in hand were also consistent with the findings of Furo (2014), and Lamidi, Oyelekan, and Olorundare (2015), who explored the effects of mastery learning on students' academic performance in the subjects of chemistry and found high academic achievements by students. Furo (2014) also found a minimum difference in the learning outcomes of urban and rural students. The findings of the present study also declared that the students of both urban and rural areas were benefited by MLM. The results of this study were consistent with Bloom's (1976) assertion, that enough time and appropriate instruction would result in the achievement of educational objectives by all learners.

It was also found that the mean achievement scores of experimental groups increased over time. Low ability students were more benefited by the application of MLM. A decrease in mathematics anxiety and an increase in self-confidence was noted in experimental groups of both areas (urban and rural).

The results declared that conventional teaching is a deficit to fulfill the requirements of all students, while mastery learning enhanced the mathematics achievement of all students. Moreover, MLM is equally effective for students of urban and rural areas to improve their performance. MLM allowed multiple opportunities to learn particular content, thus built a strong base for constructing new knowledge at every step of learning. It is, therefore recommended that teachers may apply MLM for the teaching of mathematics at the secondary school level**.**

The present study was limited to the secondary school female students of district Mardan. Further researches may explore the effects of MLM on students' learning outcomes at a different level of the school, in different subjects and on both genders in different cultures of Pakistan, as the Pakistani society is composed of diverse cultures and ethnic communities.

As mastery learning is based on individual differences, so it may be tested in all areas of the cognitive, affective and psychomotor domains in different cultures.

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