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# A STUDY ON EFFECTIVENESS OF REMEDIATION IN LEARNING OF MATHEMATICS COMPETENCIES BY ELEMENTARY SCHOOL CHILDREN

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**Abstract**

Learning in any school subject is a continuous process where by acquisition of one competency is a pre requisite to the acquisition of some other competency. The new discoveries in physical, chemical and biological sciences that have come- up and those that are in offering are all the outcome of investigations guided by mathematical thinking and computer modeling and its applications. The invention and use of

computers which makes the present age to be called 'computer age' is itself a testimony to the unique place that the mathematics enjoys in the realm of human knowledge. The view that mathematics is a difficult subject is ill founded because mathematics premises are obvious and the reasoning is simple. It is only in mathematics one can solve problems by applying the principles learned. Unlike in many other subjects, rote learning does not help in mathematics; on the other hand the students have to think logically. The study aims to assess the effectiveness of remediation in learning of mathematics competencies by elementary school children.

Keywords: investigations, reasonin, effectiveness and competencies

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**Introduction**

Indian elementary school system is not a monolith but a mixture of several systems within it. We have the schools following different curricula, providing instruction in different media, managed by different agencies, managements, located in differing geographical area, attended by different strata of society and by different gender groups, to mention a few. The differences and disparities hence are in terms of the type of school as well as the type of children who undergo their education in these schools. In the light of existing differences and disparities in quality of schooling, will universalisation of elementary education needs comparable standard and quality education for all school going children in India? If the standards of education and the outcomes from the school are not equal, does it not mean that universalisation will merely boil down to universal enrolment?

Learning in any school subject is a continuous process where by acquisition of one competency is a pre requisite to the acquisition of some other competency. At any stage, acquisition of a competency is not an end in itself. The learning continuum is a progression of competencies from the earliest learning experiences to the level expected to be achieved at the end of the elementary schooling. However, for reasons of convenience in organization and implementation, It should be possible to divide the learning continuum into as many levels or learning as there are grades. Each such level can be called "Minimum level of Learning" MLL for the respective grade.

According to the committee on MLL (1991), MLL would actually represent a rational criteria adopted for judging the adequacy of the curricular inputs provided and the learning outcomes to be expected, Basically, the MLL is useful for developing learning situations but they could also be of importance in evaluation.

**Importance of Mathematics Education**

According to Roger Brown, as quoted in Panchalingappa (1994), Mathematics is the gate and key of the sciences. Neglect of mathematics works injury to all knowledge.
Comte remarked "All scientific education which does not commence with mathematics is of necessarily defective at its foundation". Even a statesman like Napoleon had recognized the importance of mathematics, According to him "the progress and improvement of mathematics is linked to the prosperity of the state". Apart from its role in the growth of the physical sciences, mathematics is now playing an increasingly important part in the development of biological sciences. The new discoveries in physical, chemical and biological sciences that have come- up and those that are in offering are all

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the outcome of investigations guided by mathematical thinking and computer modeling and its applications. The invention and use of computers which makes the present age to be called 'computer age' is itself a testimony to the unique place that the mathematics enjoys in the realm of human knowledge. The advancement of automation and cybernetics, scientific and technological development makes it all the more imperative that special attention be devoted to the study of mathematics. Unless they have a fairly good knowledge in mathematics, children will be handicapped even to grapple with the current developments in several fields which have come about as a result of applications of mathematics, let alone pursue work at higher levels. Therefore, proper foundations in the knowledge of mathematics should be laid at school.

**Difficulty**

The view that mathematics is a difficult subject is ill founded because mathematics premises are obvious and the reasoning is simple. It is only in mathematics one can solve problems by applying the principles learned. Unlike in many other subjects, rote learning does not help in mathematics; on the other hand the students have to think logically.

**Statement of the Problem**

The study aims to assess the effectiveness of remediation in learning of mathematics competencies by elementary school children.

**Need and Importance of the Present Study**

The Education is intended to develop basic learning skills, reading, writing and arithmetic and life skills, necessary for the children to survive and improve the quality of life. During childhood, developments in the domains of literacy and numeracy take place through acquisition of basic learning competencies (BLC). These competencies represent levels of learning in a particular subject comprising basic knowledge, understanding, abilities, interests, attitudes and values. The competencies are essentially to be acquired by the end of a particular stage or standard of education. As far as the primary stage is concerned it is in fact the foundation stage for the development of basic competencies (BAS, 2002). Primary education in particular has remained a serious concern of the nation since independence. A large number of programmes and schemes have been initiated both by the Central and State Governments to realize the goal of the universalization of primary education. This has led to the opening of a large number of schools with emphasis on enrolment and retention coupled with focus on quality of education. The quantitative expansion seems to have diluted the quality of education. Research studies conducted both at national and state levels point out low level of learning in schools

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and the situation becomes worse as children move to higher classes. Poor level of achievement at primary stage is a big de-motivating factor resulting in repetition and drop out from the schools.Though there are a number of factors which determine the quality of education, the most vital one that attracts the attention of one and all is the level of achievement. These levels of achievement for any nation are so important that they need to be known periodically to keep a tab on the general health of the education system. Such a requirement warrants the conduct of periodical achievement surveys at different stages of school education in order to initiate remedial measures for improving the quality of education. National Policy on Education (NPE) - 1986 recommended the conduct of periodical achievement surveys at all stages of school education. This has also been reiterated in the National Curriculum Framework for School Education-2005.

**Operational Definition of Terms**

1. **Diagnosis:** Diagnosis is defined as the identification of a trouble/ difficulty in learning concepts in mathematics

2. **Competencies:** In MLL approach the textual concepts are broken into detailed competencies, subcompetencies and subskills(NCF,2005). In this context concepts from V standard mathematics have been identified as competencies, subcompetencies and subskills.

3. **MLL:** The minimum expected competencies that a learner should possess after the completion of a particular task or grade of learning.

4. **Masters and Non-masters:** Those students who secure 80% and above of the competencies are called masters and other are called as non-masters.

5. **Remediation:** In this context remediation is to teach the basic competencies in which students found to be lagging behind based on pre-test.

**Objectives of the Study**

The main objectives of the study are

1) To study the level of mastery of MLL's in mathematics of V standard students in selected primary schools of Shimoga District

2) To identify the MLL attainment levels in mathematics of V standard rural and urban students of government primary schools of Shimoga District.

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3) To find out the difference between male and female students in MLL attainment levels in Mathematics of selected schools of Shimoga District..

4) To study the effectiveness of the diagnosis based remedial programme in improving the proportions of students mastering each competency as well as in improving the overall competency (% of competencies mastered) by the group of V standard students in the selected (experimental) schools of Shimoga District.

**Hypotheses**

1) *There is no significant difference between male and female students in MLL attainment scores in Mathematics of schools of Shimoga District.*

2) *There is no significant difference between rural and urban students in MLL attainment levels in Mathematics of schools of Shimoga District.*

3) *There is no significant difference between control and experimental group in the effect of diagnosis-based remediation programme in improving the proportionate of students mastering each competency (percentage of competency mastered)by the group of V standard students in the selected*
*(experimental) schools of Shimoga District*

**Design of the Study**

This is an experimental study with pre and post test design. In this study the investigator has selected 18 sub competencies from V standard text book of mathematics. These 18 sub competencies from seven main areas (competencies) were selected because in all the selected schools these competencies were taught in first semester. Based on these MLL competencies investigator adapted a standard test developed by Dr. H. M. Kashinath in the year 2005. The adaptation was made in the light of competencies taught. The adapted test was also tried out on 30 V standard students. The test finalized by dropping the competencies which were very easy and ware very difficult. The opinion of various experts was also taken for finalizing the adapted test. The test was used as pre and post test for assessing the effectiveness of the intervention for learning non mastered competencies. The investigator also planned and developed teaching strategies for teaching each sub-competency selected. The details of these strategies have been discussed below. The investigator used these strategies for all non-masters from experimental group. The investigator took one session in each school on alternative days for the

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experimental group. In this way the investigator covered all the non-mastered competencies during two months of intervention. After two months of intervention for the experimental group, the investigator conducted post test for both controlled and experimental groups. The controlled group students were attending regular classes whereas students from experimental group were attending the intervention class outside the class room which was taken by the investigator himself. The performance of the students from pre and post tests was analyzed to assess the effectiveness of intervention on learning.

**Sample**

To select the sample the investigator in first phase visited schools to gather the data regarding the students' background information from selected schools. The investigator conducted pretest on all the students of 166 schools to diagnose non masters in mathematics to form sample of the study for selecting sample to represent the total population of non-masters based on pre-test in mathematics, the investigator selected 10% of total population on random basis from V standard students from the selected schools of Shimoga district. Investigator selected carefully the 10% 0f students from rural, urban schools and also from boys and girls from the toal selected sample. Investigator maintained the same 10% representation in selection of gender. Total 166 schools randomly selected from the all seven blocks for meeting 10% representation of the sample selected. Information regarding type of school, infrastructure etc., was obtained from *Sarva Shiksha Abhiyan* (SSA) office, Shimoga district of Karnataka State. After selection of 10 % of students from 166 Government primary schools of seven blocks of Shimoga district, researcher visited all the Block Education officers and Block Resource Persons to get the permission for collecting data needed for the study.

In the Second Phase the researcher collected the data from these schools. The researcher visited all the schools in person and administered the pretest himself with the help of BRC's ensuring the confidentiality of the data.

The sample of the study initially includes 1457 students from 166 schools of seven blocks of Shimoga district, Karnataka. All the Government Primary schools of Shimoga district formed the units of the study. 10% of students selected from each block to achieve first objective of the study. This sample was stratified on the basis of rural and urban locale. All the V standard students studying in these schools initially formed sample of the study. At the end of first semester the students were given pretest to assess their attainments on the MLL competencies taught in Mathematics.

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In order to serve the second objective of the study, four schools out of 196 schools were randomly selected from Shimoga district. On the basis of performance on competencies included in the pre- test of Mathematics the masters and non-masters identified were listed. Those students who were found achieving less than 80% of the competencies were non-masters and they were considered for experimental group.

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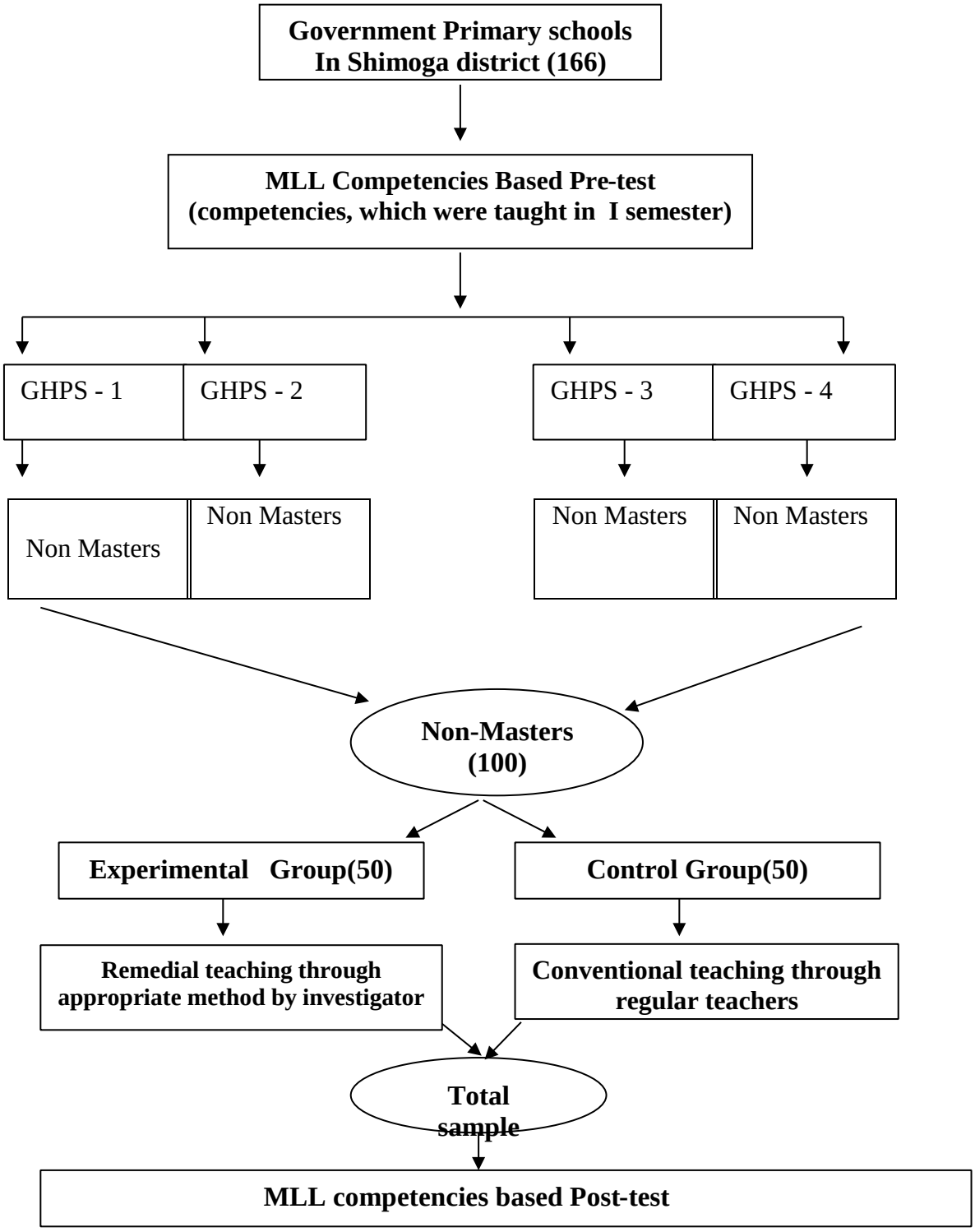
**Figure1.Selection of the Sample is diagrammatically as shown below.**




**TOOLS**

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**MLL Competency Based Test in Mathematics**

For assessing, MLL competencies taught in first semester were made as base for adapting the test which was developed by H.M. Kashinath, *et:al*., 2005. The investigator confined to the competencies taught only in I semester to V standard students.

**Statistical Techniques Applied**

Using SPSS for windows (version 16.0) following statistical methods were employed for the data collection in the present investigation.

1. Contingency coefficient analysis
2. Independent samples 't' test
3. One-way Analysis of Variance
4. Duncan's Multiple Range test
5. Repeated measure ANOVA

**The Limitation of the Study**

1) This study comprises only 100 non masters from the V standard of (50 from) urban and (50 from) rural government primary schools from Shimoga district.

2) Only Kannada medium was taken up for study.

3) The MLL competencies which were taught in I semester only were considered.

The present study aims to assess the effectiveness of remediation in learning of mathematics competencies by elementary school children, Hence, the research conducted related to explore effectiveness of any strategy or on attainment of MLLs needs to be analyse to have clarity on the present status of attaining MLL in mathematics in contexts of rural and urban elementary school goers as well as the review of related literature (includes those expositions made by theoreticians in education and psychology whose work) forms the basis for the instructional strategy developed for the present study. The earlier chapter has gone into a detailed account of the theoretical basis for this study and the empirical support on which they rest. In this chapter, a detailed review has been made of the studies that provide an empirical basis for the present investigation.

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A good deal of research has gone into methods and strategies of teaching different subjects, including mathematics. The effects of methods and strategies have been evaluated on a variety of variables. They include personality type, achievement, intelligence, level of thinking, sex, concept attainment, motivation, general mental ability, self-concept attitude towards the subject, towards the subject knowledge, understanding and application aspects of learning, study habits, etc. The methods and strategies that are studied by researchers for their effectiveness include Individualized Instruction, Lecture cum Discussion method, Inductive Discussion , Drill, Auto Instruction, Group Discussion, Ausubel's and Bruner's Strategies, Programmed Learning, Activities and Experiments, Mastery Learning Strategy, Analytic Synthetic methods, etc.

As the present study aims at assessing the diagnosis based remediation on attainment of MLL in mathematics, the studies on remedial teaching have also been mentioned in this chapter. Since this area of research has witnessed a great deal of research activity, one finds several meta-analytical studies covering major aspects of mastery learning. These and the other studies connected directly with the remediation developed by Carroll and Bloom have been included in the review of literature. Further, the studies conducted by Indian researchers in the area of remedial teaching, for obvious reasons have received a special attention in this chapter.

Guskey and Pigott's (1988) study has also investigated into three variables related to time viz., time on task, student attendance and attrition rates, and instructional time. All three of these variables showed positive effects. Remediation time spent by students and instructors significantly decrease as, the student reaches higher instructional units. The authors state that learning rate appears to be an alterable characteristic and mastery learning procedures may be one way slow learners can be helped to increase the rate at which they learn. When investigating student affect the authors found students who learned under mastery conditions generally liked the subject they were studying more, were more confident of their abilities in that subject, felt the subject was more important, and accepted greater personal responsibility, for their learning than students who learned under non-mastery conditions. In the area of mastery and its effects upon teachers it was found in one study that the expectations formed by teachers about students' abilities was increased because many students had far greater achievement than the teacher originally anticipated. It was found that the teachers who use mastery learning and see improvement in student learning outcomes began to feel better about teaching and their roles as teachers. The authors found the effects of mastery learning were positive but not as large as mastery learning advocates had suggested. They suggested further studies in all areas.

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Kulik and Bangert Downs (1990) conducted a meta-analysis involving 108 evaluations of mastery learning programmes. The outcome measures used were performance on examinations at the end of instruction, attitude towards instruction, attitude towards content, and course completion. Performance on examinations at' the end of instruction showed positive effects on student achievement although these effects were higher on locally prepared examinations than on nationally standardised test. The majority of studies showed a positive correlation in student attitudes towards instruction and content of mastery learning programmes. When analysing 32 studies related to course completion comparing mastery and traditional classes, only nine studies found a higher completion rate in the mastery class. This reduced effect was found to be related to selfpaced mastery learning.

A large number of studies have compared the cognitive consequences of mastery learning strategy with conventional methods of teaching. Airasian (1967), Collins (1969), Reese (1976), Mekin (1977), West (1979), Dunklenberger and Knight (1981), Hallade (1982), Mathews (1982), Arlin and Webster (1983), Reed (1983), Koczor (1984), Srivastava (1984), Gatipon (1984), Ferris (1985), Hefnes (1985), Bacon and Hawkins (1985), Tipps (1986), Sullivan (1987), Hadfi (1994), have considered some of the following cognitive aspects in their studies. Academic achievement transfer of learning (savings transfer), retention of achievement, minimum competency test, reading, reading vocabulary and reading comprehension scores, varying degree of instructional alignment on test scores, listening, speaking and writing scores, etc. Among these studies, more number of studies are in favour of mastery learning instructional strategy for being superior to the traditional methods of teaching with respect to the cognitive variables that are mentioned above. However, the studies of Mekin (l978), Reed (1983), Gatipon (1984), Ferris (1985), Becon and Howkins (1985) show no significant difference in the two methods of teaching that were compared. But findings of Hefnes (1985) were neither completely in favour of remedial teaching nor show complete insignificant results. This research study was designed to examine the effectiveness of the mastery learning/competency-based instructional approach in facilitating the retention of achievement in language arts and mathematics. It revealed that there was no significant difference in language arts achievement when experimental group was compared with control group either on the post-test or on the retention test. But in the achievement in mathematics there was a significant difference in favour of the experimental group.

**Hypothsis 1:** *There is no significant difference between male and female students in MLL attainment levels in Mathematics from selected schools of Shimoga District.*

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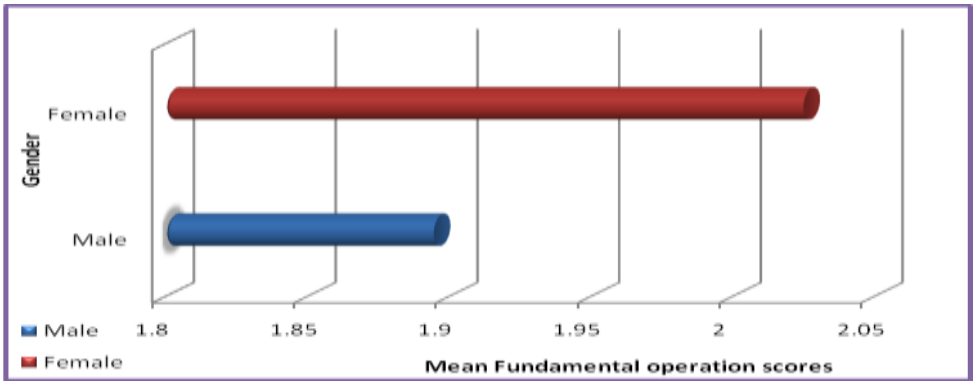
**Table 1: Comparison of means on various competencies between male and female students and results of Independent samples't' test**

| Competencies | Gender | Mean | S.D | 't' value | P value |
|---|---|---|---|---|---|
| C1-Number | Male | 3.87 | 1.13 | 0.397 | 0.692 |
| | Female | 3.84 | 1.13 | | |
| C2-Different numerals | Male | 1.80 | 0.45 | 1.308 | 0.191 |
| | Female | 1.83 | 0.40 | | |
| C3-Fundamental operations | Male | 1.89 | 1.04 | 2.318 | 0.021 |
| | Female | 2.03 | 1.11 | | |
| C4-Fractions, decimals, and percentages | Male | 2.57 | 1.15 | 1.846 | 0.065 |
| | Female | 2.68 | 1.13 | | |
| C5-Decimal's fundamental operations | Male | 1.84 | 0.99 | 1.290 | 0.197 |
| | Female | 1.91 | 0.98 | | |
| C6-Decimals addition and subtraction with mixed operations | Male | 2.01 | 0.99 | 0.384 | 0.701 |
| | Female | 1.99 | 1.02 | | |
| C7-Angles | Male | 2.15 | 0.96 | 1.763 | 0.078 |
| | Female | 2.06 | 0.97 | | |
| TOTAL | Male | 16.12 | 4.16 | 0.991 | 0.322 |
| | Female | 16.35 | 4.47 | | |

Only in Fundamental operationscompetency, significant difference was observed between male and female students as the obtained 't' value of 2.318 was found to be significant at 0.021 level where female students had high scores (means 2.03 and 1.89 respectively). In rest of the components as well as in total mathematics scores 't' value revealed non-significant differences between male and female students on the whole hypothesis 4 is accepted where in all the competencies except one competency and in total mathematics scores, the performance of male and female students had statistically equal scores (Fig. 4.6 (i)).

**Figure 2: Mean scores of male and female students on MLL CompetencyFundamental operations**



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**Hypothesis 2:** *There is no significant difference between rural and urban students in MLL attainment levels in Mathematics of schools of Shimoga District*

**Table 2: Comparison of means on various competencies of students hailing from urban and rural areas and results of Independent samples 't' test**

| Competencies | Area | Mean | S.D | 't' value | P value |
|---|---|---|---|---|---|
| C1-Number | Urban | 3.66 | 1.22 | 3.084 | 0.002 |
| | Rural | 3.90 | 1.10 | | |
| C2-Different numerals | Urban | 1.85 | 0.40 | 1.183 | 0.237 |
| | Rural | 1.81 | 0.43 | | |
| C3-Fundamental operations | Urban | 1.86 | 1.13 | 1.610 | 0.108 |
| | Rural | 1.98 | 1.06 | | |
| C4-Fractions, decimals, and percentages | Urban | 2.54 | 1.19 | 1.384 | 0.166 |
| | Rural | 2.65 | 1.13 | | |
| C5-Decimal's fundamental operations | Urban | 1.89 | 1.02 | 0.237 | 0.812 |
| | Rural | 1.87 | 0.98 | | |
| C6-Decimals addition and subtraction with mixed operations | Urban | 1.77 | 1.05 | 4.013 | 0.000 |
| | Rural | 2.04 | 0.99 | | |
| C7-Angles | Urban | 2.03 | 1.01 | 1.227 | 0.220 |
| | Rural | 2.12 | 0.96 | | |
| TOTAL | Urban | 15.63 | 4.48 | 2.490 | 0.013 |
| | Rural | 16.37 | 4.27 | | |

Only in number competency, different numeral competency and total competencies overall performance of students on all the competencies it was that significance differences between rural and urban areas were observed, where 't' values of 3.084,

4.013 and 2.490 were found to be significant at 0.002,0.000 and 0.013 levels respectively, where rural students had high scores (means=3.8981, 2.6442 and 16.3689 and 3.66, 1.77 and 15.3 respectively) than urban students. In rest of the competencies 't' value revealed non significant differences between rural and urban students on the whole hypothesis 5 is accepted where in all the conpetencies, except numbers competency, Decimals addition and subtraction with mixed operations and overall scores of all the competencies of rural and urban students was found to be statistically equal scores.figure4.7(i)

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**Figure 3 (a): Mean scores of urban and rural students in numbers competency, Decimals addition and subtraction with mixed operations and overall scores of all the competencies**

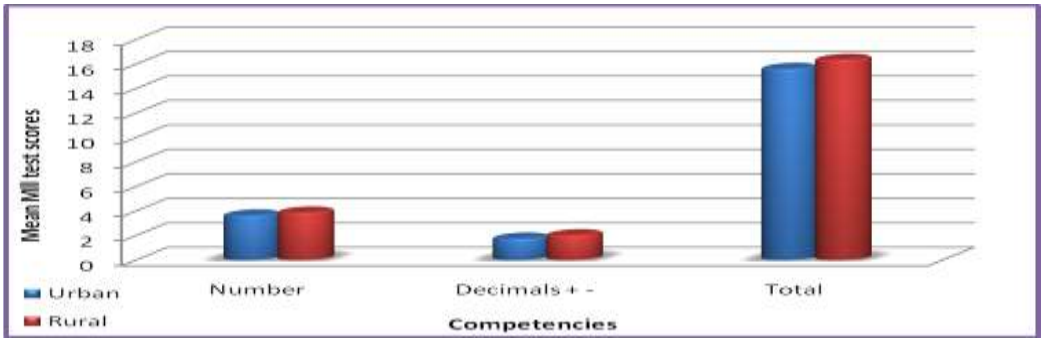


**Table 3(b): Comparison of means on various competencies of students studying in different taluks and results of One-way ANOVA for competencies numbers, Different numereals, Fundamental operations, Fractions, decimals and percentages.**

| Competencies | Taluks | Mean | S.D | F value | P value |
|---|---|---|---|---|---|
| C1-Number | Soraba | 3.32 | 1.20 | 11.365 | 0.000 |
| | Thirthahalli | 3.70 | 1.00 | | |
| | Hosanagara | 4.05 | 1.04 | | |
| | Bhadravathi | 3.79 | 1.00 | | |
| | Shimoga | 4.14 | 1.12 | | |
| | Sagar | 4.03 | 1.13 | | |
| | Shikaripura | 3.74 | 1.22 | | |
| | Total | 3.86 | 1.13 | | |
| C2-Different numerals | Soraba | 1.80 | 0.42 | 1.752 | 0.106 |
| | Thirthahalli | 1.81 | 0.48 | | |
| | Hosanagara | 1.92 | 0.28 | | |
| | Bhadravathi | 1.79 | 0.44 | | |
| | Shimoga | 1.82 | 0.39 | | |
| | Sagar | 1.81 | 0.47 | | |
| | Shikaripura | 1.80 | 0.44 | | |
| | Total | 1.82 | 0.42 | | |
| C3-Fundamental operations | Soraba | 1.73 | 0.99 | 15.177 | 0.000 |
| | Thirthahalli | 1.80 | 1.10 | | |
| | Hosanagara | 2.47 | 1.14 | | |
| | Bhadravathi | 1.87 | 1.03 | | |
| | Shimoga | 1.63 | 0.95 | | |
| | Sagar | 2.11 | 1.05 | | |
| | Shikaripura | 2.19 | 1.08 | | |
| | Total | 1.96 | 1.07 | | |

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| | | | | | |
|---|---|---|---|---|---|
| C4-Fractions, decimals, and percentages | Soraba | 2.51 | 1.08 | 3.965 | 0.001 |
| | Thirthahalli | 2.57 | 1.10 | | |
| | Hosanagara | 2.95 | 1.00 | | |
| | Bhadravathi | 2.43 | 1.22 | | |
| | Shimoga | 2.69 | 0.96 | | |
| | Sagar | 2.62 | 1.25 | | |
| | Shikaripura | 2.69 | 1.21 | | |
| | Total | 2.63 | 1.14 | | |

Several studies have been conducted in India and abroad relating to the effectiveness of various strategies of teaching mathematics and remedial programmes designed in many ways by researchers. Gusky and Gates (1986) surveyed 46 research studies relating to the effectiveness of blooms mastery learning approach and found that in most of the studies mastery learning approach was beneficial. It is significant to note the positive effects of this approach were more in language and arts than in mathematics and science. Airasian (1967) and Colins (1969) found that the mastery learning approach was better than conventional method of teaching. Similarly Reese (1976) reported positive effectiveness of remedial teaching over conventional teaching in learning algebra. Block (1970), Reed (1993), Kersh (1990), Meverrech (1986), Kulik *et. al.* (1990) have reported beneficial effects of mastery in learning approach on learning mathematics.

In India also several studies have been conducted on the effectiveness of several kinds of intervention programmes. Archana Srivastava (2004) showed better achievement level was observed on the part of students with mathematical disability after teaching them with the help of remedial programme. Sullivan (1987) found in his study that students who were thought through mastery learning method scored significantly higher in mathematics than students taught through traditional method. Kumar, Surinder, Susma and Harizuka (1996) found significant difference between experimental and control groups after teaching mathematics through cooperative learning. They found positive interaction among students. Amruthavalli Devi (2008) studied the effectiveness of strategy of teaching mathematics developed by her based on Piaget and Vigotski's views. She found significant difference between pretest and posttest scores in all the four variables studied namely mathematical thinking, creative thinking, intelligence and mathematics achievement. The above studies have shown positive effect of well designed intervention programme (including remedial programmes and new teaching strategies like discovery method, cooperative teaching, etc). Rastogi (1983) attempted a study on

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diagnosis of weaknesses in arithmetic as related to the basic arithmetic skills and their remedial measures and he revealed that basic arithmetic skills could very quickly and conveniently be mastered through the course of self-help in basic arithmetic skills as developed during the study. Vyas (1983) attempted a study on development of symbol picture logic programme and to study its effect on mathematics achievement the students of the experimental group who were given a treatment of the SPLP showed better achievement in mathematics than the control group students. Yadav (1984) found that after the experimental treatment, the experimental group of pupils exhibited a significantly higher achievement in mathematics than the control group of pupils and higher gain scores of achievement in mathematics and different percentile achievement scores of the experimental group of pupils were found to be significantly higher than those of the control group of pupils at post-test stage. Das and Barua (1986) studied on effect of remedial teaching in arithmetic among grade IV pupils and they revealed that the major conclusion of the study was that remedial teaching had definitely improved significantly the achievements in arithmetic. Dutta (1986) attempted on learning disabilities in the reasoning power of the students in geometry-diagnosis and prevention and he found that the experimental groups taught by audio-visual materials and techniques achieved significantly more than the controlled groups taught by conventional methods.

However, some of the studies indicated non-effectiveness of intervention programmes. Kirikire (1981) studied the impact of objective based lesson plans on the class room verbal interaction of behaviour but he did not find any significant effect. Wagh S K (1981) developed a multimedia instructional system for remedial teaching about fractional numbers but did not find significant difference in the achievement of the experimental and control groups. Multimedia system and traditional system both were effective to the same extent. Elfar (1982) evaluated two procedures – diagnostic and prescriptive in terns of proportion of students achieving mastery level in learning algebra but he did not find any significant difference between these two procedures. But he found significant difference between the two experimental groups (treatment 1 and 2) and the control group.

In the present study also the experimental group gained significantly higher competencies in total scores than the control group, Male students of experimental group gained most but if we analyze competency wise the experimental group significantly gained more than the control group in competencies ”fundamental operations“, “fractions, decimals and percentages”, “decimal fundamental operations” and “decimals addition subtraction with mixed operation”. In other competencies like “numbers”, “different numerals” and “angles” the gain of the experimental group was moderately observed over the control group. So it indicates that the remedial teaching programme with reference

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to these competencies needs to be revised and strengthened. It is significant to note that the male students gained more than the female students in competencies like “fundamental operations”, “decimal fundamental operations” and “angles” and in total competency scores. So in conclusion it may be said that the effect of remedial programme was not uniform across the competencies in mathematics and it needs to be further modified.

The solution to this problem, however, is not to avoid abstract objects like fractions, or even to replace rules for manipulating them with situated practices such as suggested by Lave (1988). These solutions use the old mistaken notion of concrete, a notion of concrete as a property of certain objects but not others, in order to restrict the domain of learning. Rather, we must present multiple representations of fractions, both sensory (pies, blocks, clocks) and non-sensory (ratios, equivalence classes, binary relations), and give opportunities for the child to interact with all of these and establish connections between them. This kind of enrichment of the relationship between the child and the fraction will make the fraction concrete for the child and provide a robust and meaningful knowledge of fractions. By establishing this kind of complex and multifaceted relationship with the fraction, the child may still not fall in love with fractions as Papert did with the gears of his childhood (Papert, 1980), but at least fractions will be brought into the "family" thus enabling a lifelong relationship with them. With long term use of manipulatives in mathematics, educators have found that students make gains in the following general areas (Heddens and Piccioto, 1998; Sebesta and Martin, 2004). These areas are verbalizing mathematical thinking, discussing mathematical ideas and concepts, relating real world situations to mathematical symbolism, working collaboratively, thinking divergently to find a variety of ways to solve problems, expression problems and solutions using a variety of mathematical symbols, making presentations, taking ownership of their learning experiences, gaining confidence in their abilities to find solutions to mathematical problems using methods that they come up with themselves without relying on directions from the teacher.

The number and math symbol cards facilitate the translation of words to numbers and symbols. This critical connecting step helps students to bridge the gap between the concrete and the abstract. This product is designed for use with partners, in small groups, in centers, or with whole group instruction. Grouws and Cebulla (2000) stated that long-term use of concrete materials is positively related to increase mathematics achievement in the report, “Improving Student Achievement in Mathematics.” This finding suggested that teachers use manipulative materials in mathematics instruction regularly in order to provide students hands-on experience that enables them to construct useful meanings for the mathematical ideas that they are learning. Grouws and Cebulla (2000) found that using small

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groups of students to work on activities, problems and assignments can increase student mathematics achievement. These researchers noted that using whole-class discussion following individual and group work improves student achievement.

Research reflects the importance of whole-class discussion following student work on problem-solving activities. Findings indicate that such discussion following individual and small group work improves student achievement (Grouws and Cebulla, 2000). The use of multimedia learning environments may offer ways to overcome these difficulties (Mayer, 2001). In multimedia learning environments, information presentation can be accomplished by using different representational formats (textual and pictorial) which maybe processed in different sensory channels (auditory and visual). Additionally, information presentation is not restricted to static displays (e.g., diagrams, pictures, written text), but the representations used can involve changes over time (e.g., dynamic visualizations, spoken text).

Effective visual representations, whether with manipulatives, with paper and pencil, or in one's imagination, show the relationships among the problem parts. These are called schematic representations (van Garderen & Montague, 2003). Cognitive processes and strategies needed for successful mathematical problem solving include paraphrasing the problem, which is a comprehension strategy, hypothesizing or setting a goal and making a plan to solve the problem, estimating or predicting the outcome, computing or doing the arithmetic, and checking to make sure the plan was appropriate and the answer is correct (Montague, 2003; Montague, Warger and Morgan, 2000).

The above studies showed that the improvement of mastery level in the competencies"fundamental operations", "fractions, decimals and percentages",
"decimal fundamental operations" and " decimals addition subtraction with mixed operation" is due to the use of adequate manipulatives, so in the present study also investigator used adequate manipulatives wherever necessary in his intervention programme. Hence it can be stated that the adequate use of manipulatives and appropriate strategies can improve the mastery level in attainment of the above competencies.

**Main findings of the study**

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**Survey findings**

1. Male and female students had statistically equal scores on all the competencies and also on overall performance, except for 'fundamental operations' where female students excelled male students.

2. Rural and urban area-wise comparisons revealed that rural students scored high in 'Numbers', 'Decimals addition and subtraction with mixed operations', and in 'total scores', than the urban students and in rest of the components students from urban and rural areas had statistically equal scores.

**Effect of remedial teaching**

1. Experimental group had gained significantly higher in general on all the competencies and also overall performance scores than the control group. Further, male students of experimental group had substantial gain in comparison to all other groups.

2. Competency-wise, in 'fundamental operations', 'Fractions, decimals and percentages', 'Decimals fundamental operations', and in 'Decimals, additions subtraction with mixed operations' experimental group found to be better significant as there is gain in comparison control group whereas other competencies
   – 'numbers', 'different numerals' and for 'angles', the effect of remedial teaching showed no significant effect on the experimental group.

3. Male subjects gained more than female students in competencies like- Fundamental operations, Decimals fundamental operations and in 'angles' and also on total competencies than female students.

4. The diagnosis-based remediation programme had maximum effect on competency (Fractions, decimals and percentage) where most of the non-masters became masters in experimental group.

The main findings are discussed along with verification of the hypothesis in the light of previous findings and suggestions offered by the experts.

**Implications**

1. It was found out from the present study that diagnosis based remediation programme leads to mastery of competencies in mathematics among non masters, but time taken for mastering competencies by all non-masters was higher than the time allotted in the school for teaching. In the rigid time frame of an academic year it would then be necessary that the competencies that are

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difficult for the students may be identified and shifted to the bridge course. This will be the requirement for the diagnosis based remediation programme prescribed for a grade to be appropriate for the learners and for ensuring universal achievement of a comparable standard by all learners.

2. The curriculum planners can design the curriculum based on concrete to abstract learning continua in mathematics by providing concrete, semi-abstract and abstract activities and games and live experiences in and around the pupils daily life activities which will lead to high level of attainment of MLL competencies.
3. Training programme can be designed for training the primary school teachers in adopting diagnosis based remediation programme for teaching mathematics at the primary level.
4. Teachers can use the diagnosis based remediation programme to achieve mastery of MLL competencies in mathematics and can also create an interest among the students to learn mathematics.
5. Findings of this study demand that teachers must try to improve the quality of teaching so that abilities of attaining MLL competencies of mathematics can be developed among children.. Teachers with the help of this study can develop their own teaching strategies to teach different subjects interestingly and innovatively.
6. The diagnosis based remediation program is useful for students who lag in decimals, percentage and fractions where one can expect better results.

**Suggestions**

1. Present remediation programme can be extended to other classes.
2. This study can be extended in government aided and private schools in urban and rural areas.
3. Studies may be conducted in other curricular areas using diagnosis based remediation programme to study the effectiveness of the strategy.
4. The effectiveness of the diagnosis based remediation programme to be verified for a full academic year.
5. A study involving other variables that may be intervening with attainment levels could be conducted for greater understanding of the effectiveness of diagnosis based remediation programme.

Though there are a number of factors which determine the quality of education, the most vital one that attracts the attention of one and all is the level of achievement. These levels of achievement for any nation are so important that they need to be known periodically to keep a tab on the general health of

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the education system. Such a requirement warrants the conduct of periodical achievement surveys at different stages of school education in order to initiate remedial measures for improving the quality of education. National Policy on Education (NPE) - 1986 recommended the conduct of periodical achievement surveys at all stages of school education. This has also been reiterated in the National Curriculum Framework for School Education-2005.

Learning of mathematics is very essential to develop life skills but as stated earlier, the achievement level of students from primary schools and particularly of female students are very poor. Hence it becomes more essential to explore the attainment levels of MLL competencies in mathematics and to over come these difficulties with appropriate remedial strategies.

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