# CHAPTER - I

# I N T R O D U C T I O N

## 1.1 Introduction.

Mathematics has always held a key position in the school curriculum. In the past the general objective of mathematics in the school curriculum was to prepare children for the life they are to live as adults, to enable them as children to use mathematics in the everyday world around them and to develop, at least for some children, mathematical literacy; and hence stress was there to make them learn rules of computation and meanings attached to these rules so that we had 'little computers' whose computations made sense to them. But there are major factors of life in this century that require us to examine a new role that mathematics education is to play in the development of citizens for the scientific, technological and industrial society which we are in the process of creating. The new revolution in science based on cybernatics and automation which is likely to be in full swing (with superpowers' Star wars programmes) by the end of the century, may have an impact on men even greater than anything that has happened so far in the human history. This has increased considerably the importance and

influence of mathematics; and hence educational needs in mathematics have completely changed. Every citizen of this complex society must understand mathematics if he is to comprehend the operation of governments and the material he reads in news papers. Without mathematics many possible careers - even careers that are unknown today - may be closed to him. In fact, not just mathematics, but a strong foundation in mathematics is needed by almost all the disciplines. Thus, in these circumstances of increased importance and influence of mathematics and changed needs of mathematics, just the computational know-how of mathematics is not enough, the development of concepts and ideas of mathematics at the elementary school level is a must. This approach makes the children 'think' - which in turn helps them to develop their thinking faculty.

## 1.2 Place of mathematics at the Elementary School level.

Mathematics education at the elementary school level is the first basic step towards the mathematics education as a whole. It has often been found that students who have not fared well in their elementary

schools are destined to have unsuccessful and frustrating experience in their school career; also one can not deny the fact that the achievement in mathematics relates to other achievements of a person in different fields. Therefore one must keep in mind that no level of mathematics is more important to people than that which they learn in the elementary school where the foundation is laid.

For a careful consideration of mathematics education at the elementary school level, the first question one must ask is : "How much and what kind of mathematics is the mind of a child able to absorb?" The answer can not be debated, it is a matter for experiment; and also partly depends on "how mathematics is taught". According to Piaget, Bruner, Zolten Dienes and others (Refer : 'Mathematics in Primary Education', UNESCO, 1966) the age period 10 to 12 years is very important in a child's life. Piaget says that it is the period during which deductive thought processes start in a child's mind and also this is the concrete operational stage. Brunner J. S. and Zolten Dienes consider this stage as a very important one in which fairly sophisticated mathematical thinking can take place. Patrick Suppes, once a director of Stanford's Institute

for Mathematical Studies in the Social Sciences and a professor of philosophy and statistics, experimented on some 8000 Californian children, aged six to eleven, during 1956-1961; also experimented some 500 children, fifth and sixth graders, in schools in the San Francisco Bay area, during 1961-63. The results indicated that beginners can understand simple mathematical concepts - if presented precisely with consistent notations; while fifth-sixth graders can certainly do the kinds of deductive proofs which are characteristic of modern mathematics. Professor Davis's fifth and sixth graders have tackled junior versions of such far fetched topics as matrices and vectors, and have programmed an IBM 1620 digital computer ! However, it is also observed that this is the stage (period of 10 to 12 years) when a child develops likes or dislikes for learning mathematics which further decides the success or failure for a child in his future career. This means, the programme of implementing mathematics education and its approach in view of the present day importance, influence and changed educational needs of mathematics certainly seems feasible but also demands a word of caution - especially so for developing countries like ours. Sufficient care of "what kind

and how much of mathematics could be taught" as well as "how these should be taught" must be taken while implementing the mathematics education programme at home - without changing the important basic objectives of mathematics education of today such as educating the people in mathematics, developing mathematical ideas, developing ability to solve problems, developing techniques of computation, developing a child's creative ability, challanging each individual in the classroom to think, making a child more and more inquisitive and hungry to learn to know further, and so on so-forth.

It may be noted here that as regards the question of what kind and how much of mathematics could be taught, some care seems to have been taken with the introduction of new mathematics, or more precisely the new approach to mathematics, in many states of India including the State of Gujarat, and with the subsequent alterations later on in view of the uneasiness felt by the classroom teachers (who were faced with the need to absorb a whole new body of content to teach their young charges) as well as the academic community of mathematicians. However, another equally important question of "how these should be taught" demands much

more and continuous attention of academic community in particular and society at large. This can not be compromised especially because the answer to the first question, and hence the success of the programme of mathematics education at school level, depends also on the answer to the second question.

1.3 The present state of mathematics teaching.

The present situation concerning teaching of mathematics can be described as one of the academic uneasiness. The new mathematics and the mathematics revolution may be making more teachers prematurely gray - inspite of the facts that academic community of mathematicians has now by and large settled the body of content of school mathematics with later alterations, thus establishing the 'new maths'; and the fact that quite a few inservice training programmes for school teachers were conducted after its introduction. Even if we consider only reasonably good schools (discarding a large number of schools where even blackboards are not available), what one observes today in most schools is the fact that the children's performance gets fitted in to usual normal distribution curve which is just not sufficient in view of the growing importance and

influence of mathematics and if the education is regarded as a purposeful activity. Given the fact that parents and almost all otherwise well educated citizens who were hitherto considerably useful at least upto the sixth-seventh grade of school education of their young wards, especially in mathematics, now find themselves completely at a loss with the new approach to mathematics; the responsibility of the classroom teacher increases manyfold.

To meet this challenge of teaching mathematics in the elementary school so as to implement today's objectives one must develop mathematical ideas. Opportunities to get an understanding of these ideas should be provided in a way that will develop an intuitive feeling for the structure of mathematics. These intuitive ideas are much more important than the formal statement of rules and properties. Ideas develop slowly. It is important that the teacher considers the specific level of development at each particular grade. An early introduction to concepts and the style of thinking in mathematics can then hasten the day when students can make applications of their knowledge not only to Physics, Statistics and Engineering but to biology, psychology and economics also. This objective

necessitates a programme different in intent from the past programmes.

The role of teacher to day has changed to develop a child's creative ability. Instead of being a 'fuel pipe' pouring in knowledge through drill, repetition, memorisation and rote learning the teacher has to become a 'spark plug' encouraging children to think for themselves - a change from 'teacher telling' to 'pupil discovering'. In discovering something for oneself, a sense of freedom and conquest is experienced. Should there be forgetting, a child is more readily able to rediscover what he forgot. It is difficult to go back and rediscover ideas if you have never had the experience of discovering them in the first place. In fulfilling this objective, it is important to encourage children to ask questions, to explore, to use their ingenuity and to think in the language of mathematics. Children then come to view mathematics as an imaginative, creative study of structure and patterns involving abstraction and generalization.

Common instructions to all children at a particular grade level, without regard to ability and

individual difference between the learners, must be avoided. Techniques of instructions must be developed so that slow learners get an opportunity to understand mathematics rather than memorizing. Under memoriter learning, the bright child who should have been encouraged to be more analytical in his thinking becomes bored with mathematics taught with little appeal to intelligence or imagination or creativity. Were he challenged to use his abilities, he might make a vital contribution to mathematics. It must be remembered that introduction of new mathematics carries with it the responsibility of making appropriate selections of materials and teaching methods suitable not only for different age levels but also for different maturity levels at the same age.

1.4 Towards the betterment of Mathematics teaching.

The fundamental question before us to day is:

> Is it desirable to expect the children's performance to get fitted into usual normal distribution curve, which one observes today in most of the reasonably good schools ?

The answer is a straight forward 'No'. The achievement distribution should be quite different from the normal curve - eventhough the individual

differences between the learner do exist and even-though individual difference between the maturity levels at the same age do exist !! This can indeed be achieved if the instructional strategies are effective. The basic task in Education, then, is to develop instructional strategies which will take into account individual differences of learners and their maturity levels at the same age in such a way as to promote the fullest development of the individual (Bloom, 1960) and such development for the largest proportion of a particular age group.

Inspite of this, it is highly surprising that each teacher begins a new term or course or concept with the expectation that about one third of his students will adequately learn what he has to teach, about one third to fail or to just 'get by' and another one third to learn a good deal of what he has to teach but not enough to be regarded as 'good students'. This set of expectations which fixes the academic goals of teachers and students is the most wasteful and destructive aspect of the present educational system. It reduces the aspirations of teachers and students, it reduces motivation for learning in students, and it

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systematically destroys the will of a sizeable group of students to complete atleast primary education under conditions which are frustrating and humiliating year after year. The cost of this situation in reducing opportunities for further learning and in alienating youth from both school and the community at large is so great that no society can tolerate it for long.

There is no doubt that the schools do provide successful learning experiences for some students - perhaps as many as one third or so. If the schools are to provide a large number of successful and satisfying students, major changes must take place in the attitudes of students, teachers and administrators as well as in teaching strategies and the role of evaluation. The goal should be how the largest proportion of the age group can acquire effectively the skills and the subject matter regarded as essential for their own development in a complex society. If school learning is regarded as frustrating and even impossible by a sizeable proportion of students then little can be done at later levels to kindle a genuine interest in further learning. School learning must be successful and rewarding as one basis for ensuring that learning can continue throughout life

as needed. The schools must strive to assure almost all students of successful learning experiences in the realm of ideas and self development.

Most students, perhaps more than 90 percent, can master what the teachers have to teach them and it is the task of teachers to find the means which will enable them to master the subject under consideration. The basic task for the purpose is to determine what one means by "mastery of the subject", and to search for the methods, and materials which will enable a large proportion of students to attain such mastery. The problem of developing a strategy for mastery learning is one of determining how individual differences in learners can be related to the learning and teaching processes. If the teacher is effective in his instructions, the distribution of achievement could be very different from the normal curve. An attempt has been made to achieve this through the development of mastery learning strategies by Bloom and his associates Block, Anderson, Burns, Galloway and Keller.

1.5 Mastery Learning:

Mastery learning is a topic which is currently creating much excitement in the international education circle - though still to pick up speed in this country. This excitement centres around mastery learning's classroom practices and its contribution towards promoting excellence. According to Block (Promoting Excellence Through Mastery Learning', Theory into practice, Vol.XIX ) mastery learning works so well that students have not only learned more effectively and efficiently through it, but have also felt better about their learning, their instruction and themselves-embrassing those who question mastery learning's views about human potential to learn and teach. Let us see what mastery learning is !

'Mastery learning' is two things. First, it is an optimistic theory about learning and teaching, it essentially asserts that any teacher can help virtually all students to learn excellently. The teacher can help 'dumb' students to learn like 'smart' students; 'slow students to learn like the 'fast' students. Such teaching, the theory contends, that it helps not only students but many teachers as well. Students acquire basic intellectual, manual and emotional competencies ensuring them that they can if they want to undertake life-long learning;

while teachers acquire some basic pedagogical skills and career rewards ensuring them that they can if they want to do teaching.

Secondly it is an effective set of individualized instructional practices that consistently help most students to learn excellently. Some of these practices are of the group-based/teacher-paced variety where students learn co-operatively with their classmates and where the teacher controls the delivery and flow of instruction (Block and Anderson , 1975). These are the practices which we adopt and are called Learning for Mastery (LFM). The remainder of these practices are of the individually-based/student paced variety where students learn independently of their classmates and where each student controls the delivery and flow of the instruction (Keller and Sherman, 1974). These practices are called "Personalised System of Instruction" (PSI). Both these varieties of mastery learning strategies assume that virtually all students can master a great deal of what they are taught in the school.

Mastery learning (Bloom 1968) offers a powerful new approach to student learning which can provide almost all students with the successful and rewarding learning experiences now allowed to only a few. It proposes that

all or almost all students can master what they are taught. Further, it suggests procedures whereby each student's instruction and learning can be so managed, within the context of ordinary group based classroom instruction, as to promote his fullest development. Mastery learning enables 75 to 90 percent of the students to achieve to the same high level as the top 25 percent learning under typical group based instructional methods. It also makes student learning more efficient than conventional approaches. Students learn more material in less time. Finally, mastery learning produces markedly greater student interest in and attitude toward the subject learned than usual classroom methods.

## 1.6 History of Mastery Learning:

Although effective mastery learning strategies have been developed only recently, the idea of learning for mastery is quite old. As early as the 1920's there were at least two major attempts to produce mastery in student's learning. One was the Winnetka Plan of Carleton Washburne and his associates (1922); the other was an approach developed by Professor Henry C. Morrison (1926) at the University of Chicago's Laboratory School.

These approaches shared many major features. First, mastery was defined in terms of particular educational objectives each student was expected to achieve. The objectives were cognitive for Washburne and Cognitive, affective and even psychomotor for Morrison. Second, instruction was organised into well-defined learning units. Each unit consisted of a collection of learning materials systematically arranged to teach the desired unit objectives (Washburne) or objective (Morrison). Third, complete mastery of each unit was required of students before proceeding to the next. This feature was especially important in the Winnetka Plan because the units tended to be sequenced so that the learning of each unit was built upon prior learning of earlier units.

Fourth, an ungraded, diagnostic-progress test was administered at the completion of each unit to provide feedback on the adequacy of the student's learning. This test either indicated unit mastery, and thus reinforced his learning or it highlighted the material he still needed to master. Fifth, on the basis of this diagnostic information,

each student's original instruction was supplimented with appropriate learning correctives so that he could complete his unit learning. In the Winnetka Plan, primarily self-instructional practice materials were used, although the teacher occasionally tutored individuals or small groups. In Morrison's approach a variety of correctives were used; for example; reteaching, tutoring, restructuring the original learning activities, and redirecting student study habits. Finally, time was used as a variable in individualizing instruction and thereby in fostering student learning mastery. Under the Winnetka Plan student learning was self paced. Each student was allowed all the time he needed to master a unit. Under Morrison's method each student was allowed the learning time his teacher required to bring all or almost all students to unit mastery.

While especially Morrison's method was popular into the 1930's, eventually the idea of mastery learning disappeared due primarily to the lack of the technology required to sustain a successful strategy. The idea did not resurface until the late 1950's and early 1960's as a corollary of programmed instruction. A basic idea underlying programmed instruction was that the learning of any behaviour, no matter how complex, rested upon the learning of a sequence of less-complex component behaviours (Skinner, 1954). Theoretically, therefore, by breaking a

complex behaviour down into a chain of component behaviours and by ensuring student mastery of each link in the chain, it would be possible for any student to master even the most complex skills.

Programmed instruction operationalized this theory as follows. The criterion behaviour was analyzed into a hierarchy of component behaviours. Each component behaviour was then presented in the basic programmed learning unit, the instructional frame. At a frame's completion, the pupil responded to a simple diagnostic question designed to indicate mastery or non-mastery of the behaviour presented, and he was given immediate feedback on the adequacy of his response. If his response was correct, his learning was reinforced and he proceeded to the next frame (i.e., behaviour). If incorrect, his error was immediately corrected so that misunderstandings were not propagated.

Programmed instruction seemed so promising that by the mid 1960's there were major attempts to develop entire programmed instructional curricula. Two well known examples were the Individually Prescribed Instruction (IPI) project at Pittsburgh (Glaser, 1968) and Stanford's Computer Assisted Instruction (CAI) project (Atkinson, 1968; Suppes, 1966). The former programme was designed to teach arithmetic, reading and science for grades K-6

while the latter focused on arithmetic and reading. Both approaches broke the subjects into a sequence of major cognitive objectives and developed programmed learning units for each objective. Unlike programmed instruction, however, all students did not proceed through the same programmed lessons. Each pupil's learning progress was constantly monitored, and on the basis of his present and past performance, learning lessons were tailored to fit his particular needs.

Programmed Instruction worked very well for some students, especially for those who required small learning steps, drill and frequent reinforcement; but it was not effective for all or almost all students. Thus while programmed instruction provided a valuable tool to help some students to attain mastery, it did not provide a useful mastery learning model.

A useful model was found, however, in John B. Carroll's "Model of School Learning" (1963). Essentially this was a conceptual paradigm which outlined the major factors influencing student success in school learning and indicated how these factors interacted. The model stemmed in part from Carroll's earlier work in foreign language learning. Here he had found that a student's aptitude for a language predicted not only the level to

which he learned in a given time, but also the amount of time he required to learn to a given level. In its simplest form;his model proposed that if each student was allowed the time he needed to learn to some level and he spent the required learning time, then he could be expected to attain the level. However, if the student was not allowed enough time, then the degree to which he could be expected to learn was a function of the ratio of the time actually spent in learning to the time needed thus;

$$\text{Degree of Learning} = f\left(\frac{\text{time actually spent}}{\text{time needed}}\right)$$

It was Bloom (1968) who transformed this conceptual model into an effective working model for mastery learning. His approach to mastery learning represented a great advance over previous strategies in two important respects. First the feedback instruments were much improved. Their improvement was attributable in part to the greater precision with which the structure of the learning units could be described. The work of Gagne, Bloom and others had provided procedures and categories for describing the unit's structure in terms of its constituent elements (new content to be learned and the cognitive processes to be used in learning that content and the interrelationships among elements. These structure descriptions provided an excellent blue print for which the diagnostic instruments could be built. The feedback

instruments improvement was also attributable to a major evaluation break-through called formative evaluation (Aira sian, 1969). Formative evaluation was designed to be an integral part of the teaching, learning process and to provide continuous feedback to both the teacher and the student regarding the process' on-going effectiveness. This information enabled the continued modification of the process so that each student could attain mastery.

Second, this strategy employed a greater variety of instructional correctives than previous approaches. The strategy assumed that quality of instruction could best be defined in terms of (a) the clarity and appropriateness of the instructional cues for each pupil; (b) the amount of active participation in and practice of the learning allowed to each student and (c) the amount and variety of reinforcements available to each learner. Under the typical group-based instructional situation of one teacher to 30 students, it was unlikely that the quality of instruction was optimal for all students. The sole function of the correctives was to provide each student with the instructional cues and/or the active participation and practice and/or the amount and type of reinforcements he required to complete his unit learning. For these purposes, the following correctives were used; small-group study sessions, individualized tutoring,

alternative learning materials (additional textbooks, workbooks, programmed instruction, audio-visual methods, and academic games), and reteaching. The small group sessions and the individualized tutoring, for example, added an important personal-social component to each student's learning not typically found in large-groups instruction. The workbooks and programmed instruction provided the student with the drill he may have required.

## 1.7 Application for Mastery Learning Theory:

Since the conception of these theoretical concepts; two different approaches to the application of mastery learning strategies have developed. The first can be labelled a teacher/development approach. Under this method teachers are trained in the theory and techniques of mastery learning and then individually or in team develop materials for the implementation of these strategies in their classrooms. This method has been widely employed in many school systems across the United States. The other approach can be labelled as curriculum/materials approach. By this method, a team of curriculum specialists, writers, artists and mastery learning experts work together to develop packages of materials which can then be used by teachers in adopting their instruction to a mastery learning format. Such materials are usually closely tied to a school system's established curriculum and sometimes

represent a complete instructional package. This method has been used in a few school systems in the United States but is developed on a very large scale in countries namely Korea, the Netherlands and several South American countries.

One of the first attempts to implement mastery learning strategies on a continuing basis took place at Olive-Harvey College in Chicago by the teacher/development approach. Several small scale studies in which these strategies were applied in school settings had been conducted prior to this, but these were generally limited to short courses covering only one or two weeks of instruction. The faculty members at this junior college were among the first groups to attempt to apply mastery learning instructional strategies in courses over an entire academic semester.

The other method of applying mastery learning is the curriculum/materials approach. The major advantage of this approach over the teacher/development approach is the speed with which large-scale implementation can be achieved. In Korea, for example, several former students of Bloom organized curriculum team which developed packages of mastery learning materials for subjects taught at the elementary and middle school

levels. With the cooperation of the National Ministry of Education, these materials were tried out, revised and then distributed to teachers throughout the country. Within a relatively short period of time (approximately 5 years), millions of children were in classes in which mastery learning instructional strategies were being employed. The wide spread use of mastery learning in Korea has resultated in dramatic changes, both in the achievement levels of children in the schools and in the country as a whole. For instance, where once only a small percentage of children scored high enough on a national examination to enter the most prestigeous high schools, now a majority of children are qualifying. Thus not only the educational system, but the entire social structure of the country is being affected (Kim et al., 1974).

## 1.8 The Present Study:

Nearly every school teacher struggles with the problem of how best to individualize instruction within the group oriented setting of the classroom. Most teachers are well aware of the fact that different students learn in different ways, and that while one instructional approach may be appropriate for some students in the class, it is likely to be inappropriate for others. But at the same time, teachers also know that the constraints of the

curriculum, the school calender and classroom management often make a completely individualized programme unrealistic. Over the past few years, a growing number of teachers have found that the teaching learning strategies associated with "mastery learning" provide them with a meaningful solution to these conflicting demands. For these teachers, mastery learning has provided useful and flexible techniques through which they have been able to better individualize instruction within their group-oriented classrooms.

In the light of the discussion presented in the preceding articles with regard to the need and importance to conduct researches at the elementary level in mathematics; it would be worthwhile to develop mastery learning strategies at the elementary level in mathematics through some researches at this level. Such type of researches not only make the organization of instruction more and more effective, but also help in generating a better insight into the process of instruction itself. Over the years the educators had been convinced that only a few students can learn what we have to teach. But hopefully the ideas and findings of the concept 'Mastery learning' is reversing this conviction (Refer Mastery Learning - Theory and Practice by J. H. Block). With the same hope the investigator is trying to achieve mastery learning in Geometry among the students at elementary level; keeping in view

the environmental situation of an Indian school. Hence the present investigation is an attempt towards developing a strategy for mastery learning in Geometry for the pupils of fifth grade.

Statement of the Problem: The present study is entitled as "A strategy for Mastery Learning in Fifth-Grade Geometry".

Objectives: The study is designed to achieve the following objectives.

1. To develop a strategy for mastery learning in Geometry for the pupils of fifth-grade.

2. To validate the effectiveness of the developed strategy.

It was thought more appropriate to present the hypothesis, methodology and analysis of this study in relevant chapters rather than presenting here in the introductory chapter.

## 1.9 Contents of the Chapters:

The present study is divided into five chapters. The first which is given here is regarding the Introduction of the Problem and its rationale. The second chapter is

entitled as 'Review of Related Literature' in which thematic presentation of research studies related to the area of mastery learning is given. The third chapter is 'The Problem and Procedure' which explains in detail about the present research problem and the methodological issues of the same. The fourth chapter is regarding the 'Analysis and Interpretation'. This chapter tells about the data collected, its analysis and interpretation. Based on these the conclusions are drawn. At last in the last chapter i.e. the fifth chapter namely 'Summary' the summary of the present problem with major findings and suggestions for the further researches is given.