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CHAPTER - I

1.0 INTRODUCTION

The Kothari Education Commission (1964-66) has rightly reported “The destiny of the nation is shaped in her classrooms.” The second statement given by the Commission is “Education as a major instrument of peaceful, economic, social and political transformation. This is to say bringing about total revolution. The reconstruction of Indian educational system to suit the needs of the society and build strong India on sound scientific technological foundation. The revolution so desired should be done right from the elementary stage.”

Dr. Radhakrishnan Commission (1948-49) very rightly pointed out “There exist a weak link between elementary and higher education in India. The link should be strengthened immediately.” This clearly explains the weakness of secondary education. The Indian government has given due importance to the primary education and is also giving equal importance to the higher and professional education but everybody has forgotten the importance of secondary education.

Secondary Education Commission (1952-53) clearly stated that “the secondary education in India is being neglected at the cost of primary education” and “the secondary education should build on sound foundation of primary education.” This is to say that if primary education becomes the foundation of building of education then secondary education becomes pillars and the walls of the building on which the roof that is higher education rests that is why secondary education commission
(1952-53) and Kothari Education Commission (1964-66) emphasised the need of reconstruction of secondary education. Both the Commission reports stressed the need of implementing dynamic methods of teaching for science and Mathematics.

It is most unfortunate to know even after the adoption of NPE (1986) the percentage of SSLC result is not crossing 50%. If we take the survey of last ten years, it is quite clear that students are unable to develop mathematical skills. So it is an urgent necessity to explore the possibility of introducing new methodology of teaching of science and Mathematics in secondary education.

1.1 Importance of Mathematics

Mathematics is an abstract science which investigates both inductively and deductively. It is a science of logical thinking and systematic reasoning. Since its inferences, results and conclusions are based on a definite process of logical thinking and reasoning, it is also called “Science of necessary conclusions.”

Benjamin, Peirce, the well known American trained Mathematicians, observed that “Mathematics is the science that draws necessary conclusions.” The foundation of good mathematical thinking establishes a good foundation for all thinking and drawn necessary conclusions. That is why mathematical learning assumes paramount place above all disciplines of arts and sciences.
It is felt that if one can get along well in Mathematics, all other subjects will follow. Any knowledge can be gained in a short span through mathematical knowledge as we remember the quotations:

“A Science is exact only in so far as it employs Mathematics.”
- Kant

“The progress and improvement of Mathematics are linked to the prosperity of the State.” - Napoleon

“Mathematics is a way to settle in the mind a habit of reasoning.” - Locke

“Mathematics is the mirror of civilization.” - Sidhu.

The civilization of a nation indicates their advancement in Mathematics. Without Mathematics scientists may not be able to design and manufacture many of our modern essentials such as electric generators, machines for the various forms of land, sea and air transportation. An engineer builds the bridge, an astronomer tells the occurrence of an eclipse of the Sun on the globe, a navigator predicts the accuracy, and thus the mathematical knowledge reflects the custom, the habits of life, the mode of living and the mental outlook of different nations. “Both the internal structures of Mathematics and the external world have been resources of inspiration for mathematical development.”

Many people are still under the impression that Mathematics should be used only as a tool for the study of other disciplines, but Mathematics has always been the back bone of science and technology. Mathematics is
vital for science and technology, the Education Commission (1964-65) has recommended that it should be taught on a compulsory basis during the first ten years of schooling." With this view to improve the science and technology "some State Boards of Secondary Education and the Central Board of Secondary Education have included some topics of modern Mathematics in the syllabi at the secondary level."

Mathematics is not only being used in science and technology, it has been widely used in education, medical education, economics, biological sciences, social sciences and in research. "Mathematics has its own light, bliss and wisdom."

The brains of mathematicians always create Mathematics, formulate theories and develop different components of maths consisting of arithmetic, old traditional Algebra, modern Algebra, Geometry, Analytical geometry, Trigonometry, Statistics, Hydro-statics, Dynamics, Hydro-dynamics, Calculus. All these branches make a common system of study known as Mathematics.

It is generally said by teachers and students that Mathematics is a difficult subject. Of course Mathematics in view of its abstractness offers greater difficulty to the expositor than any other science. "We can learn to play the violin by watching and hearing a concert but not Mathematics." It racks the brains of those who practice and do it number of times. Research in Mathematics is mainly for those people who are interested to dive into intellectual oceans to collect gems of human intellect. "Mathematical problem fascinates, intoxicates, vexes, gives of failure and pleasure of success."
Mathematics awakes, arouses, embraces, inspires those who are dedicated to it. The same author Bajpai said that "Rene Decartes invented the basic ideas of Analytical geometry from his dream on the night of the 10th Nov. 1619. Mathematician Ramanujan used to say that Goddess of Namakkal inspired him within the mathematical results in his dream. The bright idea of the famous "Principle of Archimedes" came to Archimedes when he was taking his bath. Weistraass, a great mathematician once remarked that a mathematician who is not also something of a poet will never be a complete mathematician. Frontenelle, another mathematician pointed out that mathematicians are like lovers."

The basic concepts and the structures of Mathematics provide a strong base for understanding and tackling the problems of a scientific society, as it is said that "Mathematics is a living and ever growing subject and not a dead and frozen product of antiquity."

New branches of Mathematics have been developed and are applied in a variety of disciplines like Computer Mathematics game theory and linear programming etc. and thus the importance of teaching Mathematics has tremendously increased. It can be concluded that all "Mathematics arose from necessity." The grown up students who opt Mathematics must have a change of heart when they see its relevance to the present day.

1.1.1 Nature of Mathematics

According to various definitions, Mathematics is the science of measurement, quantity and magnitude. The new English Dictionary defines Mathematics as "an abstract science which investigated deductively the
Mathematics is the science of logical reasoning. As Locke has said, “Mathematics is a way to settle in the mind a habit of reasoning.” The reasoning in Mathematics is of peculiar kind and processes a number of characteristics such as simplicity, accuracy, certainty of result, originality, similarity to the reasoning of life and verification.

According to great thinkers and philosophers, the study of Mathematics is the easiest of all studies. This is because in Mathematics the premises are few. It's conclusions depend upon pure logic and they follow necessarily from the premises so as to require almost no effort from a trained mind. Great thinkers who investigate some of the deepest problems of life, social, moral and intellectual, find that all their reasoning does not avail them much in coming to definite and accurate conclusions. But in Mathematics they are always able to arrive at definite and accurate results. (Kuppuswamy, 1982).

Another most important characteristics of Mathematics which distinguishes it from other subjects is it's peculiar language and symbolism. Mathematical language and symbols cut short the lengthy statements and help the expression of idea or things in the exact form. Most of the later progresses in Mathematics depends heavily on the learner's ability to employ mathematical language and symbolism. It is reasonable to mention here that most of the results of scientific inventions and discoveries are stated through language and symbolism. (Sidhu, 1996).
Most of the mathematical figures are topological in nature. Because one figure can be transformed into the other without breaking or tearing. For example, properties of connectivity and orientability that persist even when the figures are subjected to continuous deformation. All such figures—circles, triangles, ellipses, polygons are topologically equivalent.

Mathematics is a purely man made science when the first wanted to know about quantity, he devised measure for doing it. Arithmetic— to solve the problem he devised a more economic instrument— Algebra. When he wanted to find the position of star he invented Trigonometry. To measure small changes he had to forge a finer instrument— the differential calculus. When he wanted to bring in social phenomena under the category of measurable things, he created a new science, statistics.

So, one of the interesting nature of Mathematics is it's correlation with other subjects, correlation between it's branches and correlation between the topics of the same branch. For e.g. Algebra is a far better method in solving many typical problems in Arithmetic. Similarly there is correlation between Algebra and Geometry; Arithmetic— Geometry etc. To the students of science and related fields, the various application of Mathematics constitute the most interesting phase of correlation. He needs the application of Geometry, Algebra and Trigonometry.

Every discovery in science owes much to applied Mathematics. It is the application of pure Mathematics involves systematic and deductive reasoning principles of applied Mathematics and have been useful in the investigation of heat, sound, light optics, navigation and astronomy. Many
theories and structures of pure Mathematics have wide applications which were not known at the time of their inventions, for example, the theory of complex number was developed from the point of view of pure Mathematics but now it finds intensive applications in electricity, radio, related fields of physics and engineering. (Sidhu, 1996).

Mathematics is a subject with a sequence. It is not easy to understand a topic of it’s when the topics that have gone before are not properly understood. This is because of the logical sequence or continuity in the different topics of the same branch. The most important characteristic feature of Mathematics is it’s problem solving nature. It is a subject of problems. It’s teaching anc learning demands solving of innumerable problems. (Sidhu, 1996). It stimulates thinking, reasoning and critical judgement in the students. Problem solving is also an operation of thinking. Several thinking operations will be engaged in problem solving activities. As students collect the data they may observe, compare and analyse. As they organize the data, they may summarise, classify, interpret and evaluate. Hence the students get engaged in analysis of the problem, reflective thinking, systematic data gathering, verification and critical study. Hence Mathematics develops our powers of acquiring knowledge, thinking, reasoning, judgement and generalization.

1.2 Aims and Objectives of teaching Mathematics

Aims of teaching Mathematics

Universally recognised aims or large purposes of teaching Mathematics in secondary schools are as follows:
i. To give individual the understanding of ideas and operations in number and in quantity needed in daily life by the citizens of our country as individuals.

ii. To develop in the individual an awareness of the mathematical principles and operations which will enable the individual to understand and participate in the general, social and economic life of the community.

iii. To provide through mathematical ideas, aesthetic and intellectual enjoyment and satisfaction and to give an opportunity for creative expression.

iv. To provide the basis of mathematical skills and processes which will be needed for vocational purpose, and

v. To help the child develop mathematical skills and attitudes to meet the demands of (a) daily life, and (b) future mathematical work in the related field of knowledge.

Objectives of teaching Mathematics

The following objectives are to be achieved by the teaching of Mathematics at the secondary stage, as presented in the guidelines and syllabi for secondary stage (1988) by the NCERT, New Delhi.

The teaching learning of Mathematics should enable the child to:

i. consolidate the mathematical knowledge and skills acquired at the upper primary stage.
ii. acquire knowledge and understanding of the terms, symbols, concepts, principles, processes, proofs, etc.

iii. develop mastery of basic algebraic skills,

iv. develop drawing skills,

v. apply mathematical knowledge and skills to solve real mathematical problems by developing abilities to analyse, to see inter-relationship involved, to think and reason.

vi. develop the ability to articulate logically,

vii. develop skill in the use of mathematical tables for problem solving,

viii. develop ability to write, interpret algorithms for problem solving,

ix. develop necessary skills to work with modern technological devices such as calculators, computers, etc., where available and develop understanding of the cause effect relationships and the interplay of variables,

x. develop interest in Mathematics and participate in mathematical competitions and other Mathematics club activities in the school,

xi. develop appreciation for Mathematics as problem solving tool in various fields for its beautiful structures and patterns etc., and

xii. develop reverence and repeat towards great mathematicians, particularly towards the Indian mathematicians for their contributions to the field of Mathematics, Astronomy etc.
1.3 Place of Mathematics in Secondary School Curriculum

Mathematics has played a predominant role not only in the advancement of civilization in general but also in the development of physical sciences and has now far wider application in other branches as well. Mathematics has been an inseparable part of school curriculum ever since the beginning of formal education and it continues to be so. The Mathematics curriculum has undergone various changes from time to time in accordance with the changing needs of the society.

Kothari Commission (1966) has wisely remarked that ‘one of the outstanding characteristics of scientific culture is quantification. Mathematics therefore, assumes a prominent position in modern education. Apart from its role in the growth of the physical sciences, it is now playing an increasingly important part in the development of the biological sciences. The advent of automation and cybernetics in this country marks the beginning of the new scientific industrial revolution and makes it all the more imperative to devote special attention to the study of Mathematics. Proper foundations in the knowledge of the subject should be laid at school (REC, 1986).

Realising the need of the social necessities Education Commission set up in 1964 recommended that Mathematics should be taught as a compulsory subject of general education upto class X. Provision of differential courses and additional or elective courses, defeats the philosophy and purposes of general education and there could be just one course in Mathematics for all. Only international numerals (Hindu-Arabic
numerals) symbols, conventions should be used right from class I onwards. Since general education envisages Mathematics for all, the selection of content should be relevant to the practical needs of every day life. The load of Mathematics curriculum should be realistic. While designing the curriculum for the primary level, the existence of a large number of single teacher schools, high dropout rate, unfavourable socio-economic conditions of a major segment of society, etc., should be kept in view.

The value or usefulness of bringing in calculators/computers into the Mathematics education system is recognized. However, many of the mathematicians are of the view that due to unsatisfactory socio-economic conditions of a vast majority of population, making the use of calculators compulsory or even optional is not desirable. On the other hand, many feel that the use of calculator after a certain stage up to which students are familiar with the process of multiplication, division, addition and substraction and use of computer should be allowed as it helps in doing the problem quickly and provides more time for them to learn. However, by and large, it is agreed that training in the use of calculators and other mathematical apparatus is desirable and should be imparted to all at a convenient point of school education.

The place of Mathematics in secondary schools can not be undermined. It has to play its own part in shaping the future generation of the country. India after independence is striving hard to improve herself into all her commitments whatever may be the sphere. Only individual and technological developments will extend its helping hand in making India
an advanced country. To achieve this development the knowledge of Mathematics is essential. The proficiency in Mathematics complements to the proficiency in science knowledge. The future of India should be shaped only in the Indian classrooms. In order to make Indians better citizens, secondary school curriculum should be so formulated that proper importance be given to Mathematics.

Mathematics is a very useful subject for most vocations and higher specialized courses of learning. But everybody who is studying it in the school is not going to be an accountant, engineer or statistician. But at such an early stage of education it is difficult to know who is going to be an engineer or banker. Psychologists, however, have shown that it is possible at this stage to determine what student could be in later life. Therefore the duty of the school is to give the high school student a broad view of what he is capable of achieving in future. He should get a broad course to be able to choose a suitable line out of that. Regarding this point S.D.Bajpai opines that ‘Secondary education is the backbone of university education. At the primary and secondary stage, the greatest impact of the present changes will be felt. The future development of the country depends on mathematical knowledge that is gained in the primary and secondary education. If the individual understands each and every step in this stage he feels happy and gets success. In view of the above facts it is not merely necessary but it is urgent to discuss what developments are desirable and means by which they can be achieved at the secondary level’ (Bajpai, 1972).
In 1932, Executive Board of the Progressive Education Association (America) established the commission of Secondary School Curriculum. This Commission subsequently established several committees to explore the respective contributions of various subject fields to general education at the secondary level; among them was the committee on the function of Mathematics in general education. This committee finally submitted its report in four parts. The first of these presents the educational philosophy which guided the committee in the formulation of the report, central in this philosophy being the premise that Mathematics in order to justify its place in the secondary school curriculum must contribute to the satisfaction of the needs of the students. These needs are enumerated in terms of the following four basic aspects of living:

i. Personal living,

ii. Immediate personal-social relationships,

iii. Social civic relationships, and

iv. Economic relationships.

This part of the report closes with discussion of the role of Mathematics in satisfying the needs of people with respect to these four aspects of living.

Mathematics does help in training and disciplining the mind. It develops the power of thinking and reasoning and gives mental exercises best fitted for strengthening the faculties of the mind. Although the opportunities of such exercises may also be given in the studying of other subject, but Mathematics enjoys a unique position in this respect, Young
remains 'Mathematics is the only subject that encourages and develops logical thinking. It enables the student to determine between essentials and non-essentials.' Bread and butter value of the subject Mathematics can hardly be denied. Directly or indirectly Mathematics does not only help everybody in earning but it helps in wise spending.

Mathematics is a social study because it has been developed to serve the personal and social needs of human kind. Mathematics is also a language in which carefully defined language and concise symbol representation are used. Mathematics is an integral part of aesthetic art because it is concerned with symmetry of form and order. Mathematics is a recreational study because it is used in many recreational pursuits and because people find pleasure and relaxation in delving into its content (Spencer, 1966).

This importance of Mathematics in secondary school curriculum, at present has been considered and widely accepted as a subject that enables the child to develop rational and logical thinking, understanding of the percepts and concepts. The value and importance of mathematical ability has greatly increased so much that every man and woman of liberal education is expected to understand the use of quantitative data in the solution of social problems and use of Mathematics in daily life.

Keeping all these points in mind, the Kothari Commission (1966) remarked that, 'Science and Mathematics should be taught as compulsory subjects to all pupils as a part of general education during the first ten
years of schooling. In addition, there should be provision of special courses in these subject at the secondary stage, for the students of more than average ability' (REC, 1966).

National Policy on Education 1986 remarked that Mathematics should be visualised as the vehicle to train a child to think, reason, analyse and to articulate logically. Apart from being a specific subject, it should be treated as a concomitant to any subject involving analysis and reasoning (NPE, 1986).

With the recent introduction of computers in schools, educational competency and the emergence of learning through the understanding of cause - effect relationships and the interplay of variables, the teaching of Mathematics will be suitably redesigned to bring it on-line with modern technological devices’ (NPE, 1986).

1.4 Present Status of Mathematics in Schools

In 1975, the National Advisory Committee on Mathematical Education (NACOME) commissioned a study of elementary school Mathematics instructions. (Thomas A. Rombert et al). The picture drawn from this survey can be summarized as follows:

The Mathematics period is of 45 minutes duration, and about half of this time is written work. The text is followed closely, but the students after likely to read at most one or two pages other than problems. It seems likely that, the text is primarily a source of problem lists. Teachers are essentially teaching the same way they were taught in school. Almost
none of the concepts, methods or big ideas of modern Mathematics programme have appeared in the classroom. Also in all Mathematics classes, the sequence of activities are the same. At first the answers were given for the previous days' assignment. The more difficult problems were worked out by the teacher of a student on the chalk board. A brief explanation, sometimes none at all, was given of the new material and problems assigned for the next day. The remainder of the class was devoted to working on the homework while the teacher moved about the room answering questions. The three limitations of the Mathematics instruction are just characterized.

First, Mathematics is assumed to be a static bounded discipline. The emphasis on teaching the skills and concepts associated with aspects of this discipline i.e. "this massive record of knowledge, independent of its place as an outcome of inquiry, and a resource in further inquiry is taken to be knowledge" (Dewey, 1916). For schools, the consequences of this traditional view of Mathematics are that Mathematics is divorced from science and other disciplines and then separated into subjects such as Arithmetic, Algebra, Geometry, Trigonometry and so on. Within each subject, ideas are selected, separated and reformulated into a rational order. This is followed by subdividing each subject into topics, each topic into studies, each study into lessons and each lesson into specific facts and skills. This fragmentation of Mathematics has divorced the subject from reality and from inquiry, such essential characteristics of Mathematics as abstracting, inventing, proving and applying are often lost (Romberg, 1985).
Second, when the record of knowledge is mistakenly taken to be knowledge, the acquisition of information becomes an end in itself, and students spend their time absorbing what other people have done, rather than in having experiences of their own. Students are treated as pieces of "registering apparatus" which store up information isolated from action and purpose. (Dewey, 1916). The daily lessons of the traditional classroom are obviously geared to absorption and not inquiry. Current research indicates that acquired knowledge is not simply a collection of concepts and procedural skills filled in long term memory. Rather, the knowledge is structured by individuals in meaningful ways, which grow and change over time.

Third, the role of teachers in the traditional classroom is managerial or procedural (Romberg, 1985). Their job is to assign lessons to their classes of students start and stop the lessons according to some schedule, explain the rules and procedures of each lesson, judge the action of the students during the lesson and maintain order and control throughout.

Furthermore, the individual lessons are selected by teachers to cover an aspect of a concept or skill within a given time allotted. In most of the schools, the concepts are taught provided for teachers via guide, syllabus or most often a text book. But the greater defect of the syllabus is that it does provide hints and instructions for teacher's guidance. As a result the teachers fail to make the learning purposeful. Lack of mathematical apparatus and concrete materials in the classroom, make the subject more abstract. Opportunity for self education is limited. Because of
the large classes the teachers can not easily judge the capacities of the individuals. Also the practical and application aspect of knowledge is not generally emphasized. Mathematics loses its appeal as it is taught in an abstract, dry and uninteresting manner.

Most of the teachers do not have genuine love for their subject and profession. They may have been forced by circumstances to take to this profession. They lack faith in the ability of the subject and therefore can not create interest among the students. Instead of making the pupils understand the meaning behind the symbols, a large amount of time is spent in doing mechanical manipulation of symbols called sums.

Even though Mathematics plays an important role in the world of science and technology, the deteriorating standards of its teaching causes inefficiency of higher technological institutions. It is the joint responsibility of all concerned to bring about necessary improvements and changes so as to popularize the subject at all costs.

1.5 Issues pertaining to teaching of Mathematics

Mathematics is visualised as a means to train the pupil to think, reason, analyse and articulate logically. Further, since quantitative treatment of a subject area, measurement, analysis and reasoning are being increasingly involved in many other subjects, the relevance of Mathematics should be seen not only as a specific subject area but also in the context of and as a concomitant to other concerned subject areas. The application of mathematical abilities in day to day life situations can not be ignored. The fundamental aspects of Mathematics at primary level can also not be
ignored in view of modern technological devices. What should be the structure of Mathematics upto 10 years of general education? What type of Mathematics should be taught? It goes without saying that mathematical reasoning demands higher mental ability. Experiences have shown that the major of students normally fail in Mathematics at the end of class X. This frustrates not only students but also their parents. Many educationists feel that Mathematics should be compulsory only upto class VIII, while some other opine that there should be old types of Mathematics courses at secondary level and senior secondary level. These courses should be need-based at secondary level. There should be one course for those who will pursue Mathematics as their future career and another course for those for whom class X will be a terminal stage. As such the important issue is what sort of mathematical skills and competency are required up to ten years of Mathematics education.

Mathematics in some of the states has been made optional. Unfortunately, in some places in lieu of Mathematics student especially girls offer Home Science. There is a strong feeling that Mathematics upto ten years of school should be functional and should not be loaded with commercial Mathematics and banking. Mathematics learning is badly affected due to the problem of the language in which books are written/developed. Concepts are not properly communicated through the language of the text books or content not properly understood by students creates problem. While considering the compatibility of our Mathematics courses upto ten years of general education, some people strongly feel that topics
of international importance may also be included in Mathematics, but these may not be made compulsory for all.

Like in science the concept of a Mathematics laboratory has emerged as a new dimension and especially so in the urban schools. Activity based Mathematics at school level is going to promote learning of Mathematics in a big way. The opinion across the teaching community and parents is that there is a lot of wastage due to failure in Mathematics at secondary level because of the present content in Mathematics. Mathematics is not very relevant to the students’ needs who would like to terminate their education at the secondary level itself.

In many schools in absence of qualified teachers Mathematics is being taught by non-mathematic teachers. The basic question that we need to address ourselves for any futuristic concern is whether Mathematics education can be left to the change of non-Mathematics person, knowing well that maximum failure takes place in Mathematics. In order to reduce this failure this situation may have to be readdressed.

The use of calculators in Mathematics learning is yet another issue that needs to be debated. Mathematicians strongly feel that at the initial stages of school education, i.e. upto Grade VI or so there should be no use of calculators. However, as soon as they reach class VII they should be allowed to use calculators as by that time the basic principles of additions, substractions, division and multiplication are clear to them.

1.6 Achievement of Indian School Pupils in Mathematics

A national level survey report (NCERT) - the broad objective of this
national survey was to find out the achievement of pupils in Mathematics at three levels of education - primary, middle, high school, all over India except Bihar and Tamil Nadu. For this purpose 15,000 schools at each level were given the tests. The results revealed that the national performance was quite below the desired level. On the objective dimension items involving applications of concepts proved difficult. Similarly was the case with items that involved more reasoning rather than rote knowledge. In most of the states, items on objectives application and logical reasoning were comparatively difficult than those on the objective knowledge and skill. Comparing the average difficulty values of the items according to objective seemed to be application followed by logical reasoning, knowledge and skill. This trend appeared in most of the states. The students had failed badly on application of knowledge to new situations, logical reasoning, evaluation, synthesis and so on (Kulkarni and Mohanlal, 1970).

Patel (1984) among other teams discovered that the pupils possessing high reasoning ability were found to be better in mathematical ability than those with low reasoning ability (Patel, 1988).

1.7 Modern Mathematics Programme in Indian Schools

The new mathematical programmes very widely in their approach and implementation different states of India. But all the programmes in different states lay stress upon the unifying themes or ideas in Mathematics such as pattern and structure, system of numeration, development of real numbers, set language, introduction of set notations,
symbols for operation, matrices and their application to geometrical transformation, simple probability and statistics.

Generally speaking significant changes have affected our school Mathematics programme. Firstly, the traditional courses of too much compartmentalisation of Arithmetic, Algebra and Geometry are substituted by new courses with emphasis on the basic mathematical structures which have common underlying principles and properties. Memorisation of number facts has been replaced by reasoning and discovery of the principles involved in the commutative, associative and distributive laws of Mathematics. Hence the emphasis in Arithmetic is on the properties of number and operations. Some simple algebraic ideas, mathematical sentences, equations, symbols etc. are introduced in the early stage of schooling. The ideas of space, point, line and plane and well defined unit of measurement have come at the elementary level itself. The set language and other number base are used to give an idea of abstract structure of Mathematics.

The second change is the use of qualitative vocabulary. In Arithmetic, for example there are such new terms and the concepts they embody as the sets, mapping or matching numeral as distinct from number, one of the correspondence order, base operations and so on. In Geometry the meaning and use of ideas implicit in the words take point, set of points, line, segment, ray, half plane and so on are developed.

The third change is that understanding the way of computational operations instead of using numbers mechanically in a memorised sequence
of steps. In new Mathematics programme, a student is required to learn that every bit of manipulation which he does has a reason. Considerable use is made of deductive reasoning and proof and basic laws of logic are developed and used.

The fourth change is that the responsibility of learning is left to the child. The discovery method is utilised whatever appropriate. The student is led to make and test conjectures of his own and formulate some principles and procedure for himself. By exposure to different ways of approaching tasks the students are encouraged to make their own Mathematics discoveries to develop mathematical insight, and to acquire in understanding many mathematical ideas.

1.8 Technical Innovations in Education

All the man’s history, until now, arbitrarily can be broken up into two periods, the second of which is now in transition to the new and third one. In the first period, which might be called the pre-science era, man was not consciously employing science to alter his society. True, he was aware of the world around him and he sought to adopt himself to nature’s laws. But, when he objectively began to develop organised ways of thought and experimentation to further his knowledge of nature, he entered the era of the discovery of science and its utilisation. One landmark in this second period is the so called industrial revolution. In this second era, now coming to an end, man learned to communicate and navigate, to create and harness sources of power well beyond his own muscles, all with the natural result of increased production and fast
transportation. This rapid and potentially dislocating scientific advance and technological growth demands new ways of adjustment on the part of individuals in social life, which, if not met appropriately, results in certain social maladjustments. Our hope for attaining any kind of stability in the highly technological world rests on the ability to look ahead, to understand the world and to adjust to it. Education plays an important role in preparing individuals to fit into the existing pattern of society and to help them explore new possibilities for further advancements in all walks of life. Right from the dawn of civilization, formal education has been accepted as a major social organ for educating the younger generation of the society. Ever since then, educational thinkers and practitioners have been continuously trying and advocating new techniques of imparting education. Educational programme today is more comprehensive in that it includes developing in individuals, not only the capacity to read and write but also the ability, for critical analysis. Through this ability the educated individual would acquire certain behaviours. For example, when he confronts a problem where decision-making is called for, he would examine the various pros and cons involved in the problem situation and make an appropriate decision. Acting in this manner would demand the fullest possible development of the individual. For this purpose, education, today, has as its objectives not only imparting knowledge and developing skills in various areas of learning, but also developing in students certain higher cognitive abilities, viz. critical and analytical thinking, abilities of application, synthesis and evaluation, along with certain affect attributes. At various points in the
history of education, educational thinkers and practitioners have been continuously trying and advocating new techniques of imparting education. Whatever the techniques might be, the emphasis has been on the enhancement of learning on the part of students. This has been sought to be achieved by making the learner more active in the instructional process.

1.8.1 Innovations in Mathematics Teaching

Earlier Mathematics was taught in schools with traditional method. Teacher dominated classes where in students learn passively taking down the written material on black board. No students were able to ask the teacher why and how about the mathematical solutions. During the recent past the teaching of Mathematics has been changed Activity based method, programmed instructions paved the way for new thinking and solving the problems of Mathematics students are able to approach the teacher at any stage in some cases students can learn by themselves in modern times with advent of computer. The Mathematics teaching/learning has taken a new shape.

1.9 Programmed Instruction

Skinner (1954) develop a new techniques of Auto-Instruction which was later termed as Programmed Instruction and Programmed Learning. This concept was based on the apparent conditioning theory in which the learning activities will be automatic after some exercises. This theory also based on Thorndike’s (1929) laws of learning. Skinner considered that the learning takes in an individual by knowledge of correct response. With
proper reinforcement he has given the following principles of Programmed Instruction.

i. The principle of small steps  
ii. The principle of active responding  
iii. The principle of immediate conforming  
iv. The principle of self pacing  
v. The principle of student testing

1.10 The Role of Teacher in Programmed Instruction

Though the strategy spins around self learning the teacher plays a vital role in the whole set up. Her role is more than of a friend, philosopher and guide. In fact, his/her very attitude to the subject and to the process is a great influencing factor on the students and their achievement through strategy he/she has to be ever vigilant to the level of need for help of the individual, encouraging, helping at every stage, building up the right attitudes of thinking and work in the students. Thus the effectiveness of the system depends on how organised and enthusiastic the teacher is in the classroom.

1.11 Importance of Computer Education

Among the various subjects, computer science is gaining importance as a necessary part of education and at present it is an optional subject at the higher secondary education. In some schools the subject is introduced as early as VI standard and from VI to X fundamental concepts of programming is taught.
In the light of what has been discussed in preceding paragraphs there is a positive need to develop an effective instructional strategy with a proper sequencing of the latest available scientific techniques that can be utilised with scheduling. The instructional strategy for teaching Algebra to students of standard IX has been planned, evolved and experimented upon, with a view to introducing individualisation of instruction into existing classrooms and blending it with the prevalent educational system by suitably incorporating certain other techniques.

1.12 Computer Assisted Instruction (CAI)

During recent past many innovative methods of teaching has been developed programmed learning and Computer Assisted Instruction. Computer Assisted Learning or some of the modern method developed Computer Assisted Instruction means the teacher while teaching uses computer with proper software for his teaching. During the process, computer and the software will help him so carry out the process of Instruction.

1.13 Computer Assisted Instruction in Schools

Individual differences of students have been a long standing hindrance to effective classrooms teaching. Right from the days of Aristotle, the emphasis in the teaching learning process has been on greater pupil involvement and participation, thus enabling the educator to be aware of the individual’s capacity for thinking, grasping and application of knowledge educational technology can, when properly administered, provide the teacher with materials and methods for maintaining an educational
programme in a classroom so that he can be freed for a sizeable portion of the time in class to work with individuals - to nurture personal values, to vitalise core disciplines and to handle personal learning barriers causing frustration. The present project has been directed towards the development, organisation and implementation of a system of techniques, having CAI as the main component, to teach fundamentals of computer at school level.

The instructional strategy has the following components:

a. Introduction by the teacher to the unit
b. Programmed learning material
c. Review - recapitulation of the basic principles and methods of the unit
d. Progress test
e. Discussion of the progress test.

1.14 The Role of Teacher in Computer Assisted Instruction

This system is no different from the question answer-method of teaching. The only difference is that the whole process of questioning is provided in the material. Though the system is, primarily based on the principle of self learning, the teacher plays a very important role in the classroom. In fact, it is chiefly his outlook, personality and attitude in the classroom that could make this system a success. The effectiveness of the system depends on how organised and enthusiastic, the teacher is in the classroom.

1. A teacher should have an open mind towards the whole system
and proceed to make the learning process an effective one.

2. That learning is possible to a fair extent though this method should be the positive outlook of the teacher in the classroom.

3. Being a self pacing system, the teacher should be aware that the individual differences between children becomes more pronounced and sometimes is alarming. That itself should form the basis of his/her technique in the classroom.

4. This difference in performance levels in day to day classroom helps the teacher to identify the weaker students and his/her concentration in class should revolve around these children. These children, very often would require formal explanations in the beginning but slowly they should be weaned away from it and encouraged to try and think more clearly. If need be, these children should be given extra practice work on the particular type of problem which they find difficult.

5. The units are normally for a period of two weeks.

6. When the unit is given out, the teacher may introduce the topic and outline the facts which should be emphasised upon and given special attention to, in the unit. However, she should safeguard against giving them all the facts in details. That would dissuade students from going through the material.

7. The students should then be encouraged to go through the material carefully and more through the frames.
8. Though the emphasis is on self-pacing to ensure that there is no slackness on the part of the student, the teacher should indicate at the beginning of a session, the frames or the exercise up to which work should be completed for that two period session.

9. Ten minutes before the two period session gets over, the work on the material could be stopped and an oral evaluation on the pages covered by the students could be conducted through suitable questioning of the students.

10. As far as possible, the students should be encouraged to move on, their own. However, where there is a common difficulty or uncertainty in the minds of the students, a timely short blackboard explanation should be given.

11. Care should be taken to avoid the tendency of returning to absolute formal teaching.

12. When the unit is over, one session could be devoted to a formal review lesson of the unit highlighting the facts and rules to be remembered.

13. We could probably keep in mind the words of Confucius on the good teacher.

"In his teaching, the superior man guides his students, but does not pull them along, he urges them to go forward and does not suppress them, he opens the way but does not take them to place. Now, if the process of learning is made gentle and easy and the students are encouraged to think for themselves, we may call the man a good teacher."
1.15 Advantages of Computer Assisted Instruction

1. Fundamentals can be learnt easily by this method. As such it saves teachers’ time.

2. Students can go through the lessons repeatedly and learning becomes easy.

3. Computer aided learning is gaining popularity. As a teacher, teaching computer science, I have practical experience with computers and as such wanted to use it effectively for instructions. Not much studies have been done in this field. Therefore, I wanted to contribute to this field of study.

1.16 Need of the Study

Everybody says that Mathematics is an abstract of science. The learning of Mathematics needs logical thinking and special skills like manipulation. The teaching of Mathematics also needs special attention towards analysis, synthesis and interpretation. In India the Mathematics teaching is carried on mostly through traditional method wherein teacher dominates in the classes; students are passive observers and they are forced to accept the interpretation written on blackboard. Usually teacher solves very few problems on the board and ask the students to copy and manipulate the questions of the students in the same way the question of how and why are unsolved by the teachers. In this way the Mathematics learning has created a type of fear in the students. Moreover, the teachers are unaware of new methods of teaching the Mathematics in secondary schools.
If we look into the SSLC results of last ten years in Karnataka State following statistics is enough to understand the performance of the students in Mathematics.

Table-1.1: Showing the Statistics of SSLC results for the last ten years (1990-1999)

<table>
<thead>
<tr>
<th>Year</th>
<th>SSLC Results</th>
<th>Failed in Mathematics</th>
<th>Failed in Other subjects</th>
<th>No.of students scored 100% in Maths.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>38%</td>
<td>50%</td>
<td>12%</td>
<td>5</td>
</tr>
<tr>
<td>1991</td>
<td>38.8%</td>
<td>51%</td>
<td>11.8%</td>
<td>4</td>
</tr>
<tr>
<td>1992</td>
<td>39%</td>
<td>49%</td>
<td>11%</td>
<td>6</td>
</tr>
<tr>
<td>1993</td>
<td>41%</td>
<td>47%</td>
<td>12%</td>
<td>8</td>
</tr>
<tr>
<td>1994</td>
<td>42.8%</td>
<td>45%</td>
<td>12.2%</td>
<td>12</td>
</tr>
<tr>
<td>1995</td>
<td>44%</td>
<td>42%</td>
<td>14%</td>
<td>21</td>
</tr>
<tr>
<td>1996</td>
<td>46%</td>
<td>43%</td>
<td>11%</td>
<td>26</td>
</tr>
<tr>
<td>1997</td>
<td>46.8%</td>
<td>41.7%</td>
<td>12.2%</td>
<td>32</td>
</tr>
<tr>
<td>1998</td>
<td>48%</td>
<td>38%</td>
<td>14%</td>
<td>36</td>
</tr>
<tr>
<td>1999</td>
<td>48.8%</td>
<td>37%</td>
<td>17.2%</td>
<td>60</td>
</tr>
</tbody>
</table>

The above statistical facts clearly show that about 44% of the students are unable to score passing marks in Mathematics. The failure in other subjects are negligible. The very few students are obtaining 100% marks. The above facts clearly indicate following observations:

1. Traditional methods of teaching Mathematics by teachers.
2. Students are not taking interest in learning Mathematics.

3. No proper evaluation procedure for Mathematics.

Mathematics is an essential subject inevitable to each and every individual. Hence one should know fundamentals of Mathematics and mathematical operations. It is also observed that most of the students do not develop or unable to develop essential skills in understanding some of the important and essential units like commercial arithmetic, Statistics, LCM, HCF, Fractions and Decimals etc.

In recent past the innovative methods have been tried for teaching of Mathematics like project method. Problem solving method, programmed instruction method etc. that is how the results were showing some upper trend in the SSLC as shown in table.

The invention of computer is a gift to human functions and abilities, now every individual can compute complex mathematical operation very easily with computers. So there is a plan to introduce to CAI and CAL in schools.

Owing to the above facts the investigator felt that there is an urgent need to know the effectiveness of teaching Mathematics through three different methods like traditional methods, through programmed text, through computer instructional package thereby to help the teaching-learning of Mathematics more effectively and more meaningful. The investigator is also planning to develop an instructional software package so as to facilitate the teachers to teach the Mathematics units very easily.
and also students can learn very effectively. Such software package may lead to other researcher to develop similarly for other units of Mathematics also.

1.17 Statement of the problem

"DEVELOPMENT AND VALIDATION OF COMPUTER INSTRUCTIONAL PACKAGE ON SELECTED UNITS IN MATHEMATICS FOR IX STANDARD."

1.18 Objectives of the Study

i. To develop and validate computer instructional package in modular style incorporating the interactivity (user friendly) features that assist school children in learning Mathematics.

ii. To develop programmed instructional frame incorporating user friendly features that assist school children of IX standard to learn Mathematics.

iii. Constructions of standardisation of criterion tests (pre and post tests).

iv. Development of the socio-economic and educational status questionnaire for the IX class students.

v. To know the effectiveness of teaching Mathematics through programmed text material to that of traditional method.

vi. To know the effectiveness of teaching Mathematics through computer instructional software package to that of traditional method.
vii. To know the effectiveness of teaching Mathematics through computer instructional software package to that of programmed text material method.

viii. To know the relative effect on the achievements of the students belonging to different socio-economic and educational status for three different treatments.

ix. To know the relative effect of achievement of Boys and Girls towards different treatments.

1.19 Terms defined

**Algorithm:** A prescribed set of well-defined rules or process for the solution of a problem in a finite number of steps. (Hussain, 1973).

**Computer assisted instruction:** Instruction delivered directly to learners by allowing them to interact with lessons programmed into the computer system. The computer system can display information, ask questions, check answers and adjust speed of presentation to how well the learner is progressing.

**Computer literacy:** The ability to understand and to use computers, parallelling reading and writing in verbal literacy. Actual computer literacy exists along a continuum from general awareness to the ability to create computer programs.

**Computer managed instruction:** The use of a computer system to manage information about learner performance and learning resources options in order to prescribe and control individual lessons.
**Computer program:** A series of instructions or statements, in a form acceptable to a computer, prepared in order to achieve a certain result. (Hussain, 1973).

**Content Analyses:** A detailed study of the contents of a course carried out in order to check that the course covers all the prescribed subject matter content. The results are often presented in diagrammatic or quantitative form. (Ellington and Harris, 1985).

**Criterion:** As part of a performance objective, the standard by which acceptable performance will be judged; may include a time limit, accuracy tolerance, proportion of correct responses required, and/or qualitative standards.

**Data Base:** A collection of data which is systematically organized so as to make retrieval, manipulation and editing easy.

**Display:** The picture which appears on the computer screen is called display.

**Documentation:** The comprehensive written information including instructions and operation manual that must accompany a software.

**Entry behaviour:** The set of skills, knowledge etc. that a learner actually possesses at the time he/she enters or begins a course or program of instruction.

**Expository Learning:** The typical classroom teaching approach that proceeds as follows: presentation of information (the main point), reference
to particular examples, application of the knowledge to the students' experiences.

**Feedback:** Knowledge of results, either positive (knowledge that your response is correct) or negative (knowledge that your response is incorrect or partly correct). Computers provide visual feedback.

**Flow Chart:** Diagrammatic or sequential representation of the solution to a problem using symbols which is then translated to a computer language.

**Frame:** In programmed instruction, one unit in a series of prompt response reinforcement units; a block of verbal/visual information. It represents contingency of reinforcement involving stimulus-response and reinforcement occurring in quick succession.

**Hardware:** The physical equipment that makes up a computer system.

**Instructional program development:** The process of analysing needs, determining what content must be mastered, establishing educational goals, designing materials to help reach the objectives, and trying out and revising the program in terms of learner achievement.

**Instructional module:** A free standing instructional unit, usually used for independent study. Typical components are (i) rationale (ii) objective (iii) pre test (iv) learning activities (v) self test (vi) post test.
Interactive media: Media formats that allow or require some level of physical activity from the user, which in some way alters the sequence of presentation.

Memory: It is a device or medium that can accept data hold them and deliver or retrieve them on demand at a later time. Memory capacity is expressed in bytes.

Pre-test: A test administered prior to a course or program of instruction in order to determine the entry behaviour of the learner. (Ellington and Harris, 1986).

Post-test: A test administered after the completion of a course or program of instruction in order to determine the extent to which the learner has achieved the specified objectives. (Ellington and Harris, 1986).

Remedial frame: A frame in a programmed instruction sequence that forms part of a remedial branch. A specific unit of instruction designed to overcome a particular learning deficiency in a learner.

Scrolling: The ability to move the text in an up and down fashion on the screen.

Software: A general term for the programs and supportive documentation that are used in conjunction with computers and other data processing systems.

Student gain: Improvement in student (or learner) performance and/or knowledge attributed to a particular course (Page and Thomas, 1979).
Terminal Behaviour: The set of knowledge, skills, behaviours etc. that a learner is expected to have acquired by the end of a course or program of instruction.

Userfriendly: In program design, userfriendly means the program puts very little burden on the user. This burden, in the case, is memorizing complex codes and instruction in order to use the program and having to respond to the computer in a way that is unnatural. A userfriendly system is easy to use, which helps when things go wrong and which tries to protect the user from making mistakes.

Thus this chapter attempted to provide broad contours of the proposed study. The chapter to follow is devoted to take stock of related literature. It is hoped that it would enable the investigator to go a head in a sound manner.