CHAPTER I

IMPORTANCE OF MATHEMATICS AND THE DESIGN OF THE STUDY

Section I Importance of Mathematics
Section II Scope of School Mathematics
Section III Curriculum
Section IV Mathematics Curriculum
Section V Design of the Study

a) Statement of the problem
b) Definitions
c) Need
d) Objectives
e) Scope
f) Limitations
g) Related Studies
h) Methods of the Study
SECTION I

IMPORTANCE OF MATHEMATICS
The present world is in the process of a technological revolution. Modern technological advances demand a variety of well-trained man-power of various grades, who can read, write, compute and have learnt how to learn. This social imperative constrains the schools to mount courses commensurate with man-power needs. A democratic form of government must rest on an electorate composed of people who know the problems and issues facing the nation, providing the basic tools of survival like reading, writing and arithmetic. The people must be acquainted with emerging issues; and have to develop attitudes and learning-habits needed to solve these problems. For these, and other reasons, the schools and colleges must assume leadership in formulating the content of the curriculum and the operational strategies. The welfare of a nation rests more heavily on the colleges and schools than on any other institution.

Education in India has undergone decades of fermentation. The growing number of children, the awakening of aspiration for higher education, and the shift from the Arts to the Sciences have indeed twisted our educational ways into new and uncharted directions; and one must be considered foolhardy if one does not realise these emerging challenges of education.
Again, the present civilisation is facing a crisis - the increasingly widening gap between the developing and the developed nations. In this connection the Indian Education Commission, 1966, had rightly pointed out:

"It is almost inevitable that the gap between the scientific work in a developing country and in an advanced country is large, but usually it is very much bigger in some parts of the spectrum than in other. However, if a developing country is to put forth its best effort, and to sustain it over a long period of time, it must seek some areas of scientific enterprise where it can expect to stretch itself to the utmost and do something of world significance. Identification of such areas is not easy. It demands great insight, courage and imagination, but it is essential to the whole morale of a nation's scientific endeavour. In this context a field of study which immediately comes to mind is mathematics."¹

"Mathematics will be close to the centre of all these turmoils, and for at least three reasons. First, as the influence of the analytical sciences outgrows that of the humanities, mathematics - the one discipline common to all the sciences - will have greater influence thrust upon it. The distinction between mathematics as a purely mathematical activity and mathematics as a problem-solving technique are likely to diffuse, a process sure to be greatly accelerated when the tremendous power of future computing machines is fully utilised. And finally, the shortage of teachers of mathematics, cannot help becoming steadily more crippling unless the most drastic remedies are undertaken."²

Everyone knows that schools change - that despite all the influences of tradition, things are not the same as they used to be. Yet, during the past decades, the change has been on such an unprecedented scale that in many ways schools have
become surprising places not only to those who work with them—like parents and employees—but even to those who work in them, like teachers and students.

"But even more spring from the way the teacher works in the classroom—from the increasing emphasis on individual methods, on creativity rather than remembering, on new pattern of assessment and examination, and on the use of a wide variety of Project methods.

Such changes have certainly transformed the life of many classrooms and made school a different place for teachers and their students."3

The science of mathematics is expanding rapidly; school mathematics lags behind, and especially so in the developing countries that lack access to the latest advances in the field. Social and technical progress depend more and more on up-to-date mathematics in an increasing range of professions. This is because mathematics is becoming a more flexible tool than it ever was in many fields of life and culture, old and new, alike.

During the last two decades there has been an explosion of knowledge in the world. Not only in the field of science, but also in commerce, industries, factories, railways and posts and telegraphs there have been tremendous developments. In all these developments, an increasing use of mathematics is evident. Earlier, mathematics was used mostly in physics and
marginally in other sciences. But now, its increased use is discernible even in economics, commerce, biology, medicine, linguistics, logic and psychology. Lots of mathematics is being used and a student of any of these subjects without the knowledge of mathematics and mathematical statistics feels himself helpless; and is unable to understand and appreciate fully the modern theories inherent in advanced studies of such subjects. The importance of the study of mathematics is basic to our well being, and needs no reiteration.

To cope with the mathematical needs of all these developments in various fields, there has been an expansion in the knowledge of mathematics. The horizons of Mathematics have greatly expanded since the turn of the century. Many new topics such as topology, probability, set theory, projective geometry, number theory, linear algebra, games theory and statistics have been added. Emphasis is more on the structure of mathematics than on the simple computations. Universities felt the impact; and changed their courses. Schools could not escape from this onslaught for long. For about twenty years mathematicians have been making efforts to bring revolutionary changes in school mathematics. Changes both in matter and method have been suggested. The approach in new mathematics is logical, laying stress on the structure of mathematics, abstract thinking and symbolic language. School mathematics is helpful
for higher studies in mathematics, the sciences, technology, medicine, trade, agriculture and banking etc. A strong grounding in mathematics is needed for all kinds of jobs. Therefore, the question before us is:

"What should be the content of School Mathematics and how should it be the best taught?"

The answer to this question is not a conventional approach to mathematics teaching, in order to equip a child with certain skills, which is inadequate, since it never gives the child a correct understanding of mathematics, its logical structure and form. It is, therefore, important for us all to determine how much of mathematics should be taught and how.

Mathematics is valuable to humanity in many ways. But it is the job of the teacher to decide what importance it has to be accorded and what value it should be assigned in the school curriculum. Unless the students understand the importance of the subject, the teaching and learning would suffer a major set back, due to the lack of clarity of purpose.

"Mathematics takes us into the region of actual necessity to which not only the actual world but every possible world must conform."4

Therefore, everybody needs some knowledge of mathematics in one way or the other.
"A person may belong to the lowest or the highest class of society, but he utilises the knowledge of mathematics in one form or the other."  

One cannot do without the use of the fundamental processes of this subject in one's life. A person ignorant of mathematics will be at the mercy of others and could easily be cheated. The knowledge of its fundamental processes and the skill to use them are the essential requirements of human existence.

"Mathematics, as an expression of the human mind, reflects the active will, the contemplative reason and the desire for aesthetic perfection. Its basic elements are logic and intuition, an analysis and construction, generality and individuality. Though different traditions may emphasise different aspects, it is only the interplay of these aesthetic forces and the struggle for their synthesis that constitute the life, usefulness and supreme value of mathematical science."  

Therefore, mathematics is called the science of logical reasoning. In it we approach everything with an interrogative attitude. As Locke has said,

"Mathematics is a way to settle in the mind, a habit of reasoning."
Therefore, right from an illiterate housewife to a planner, all use mathematics, of course in varying degrees and levels of sophistication.

Mathematics disciplines the mind. J.P. Wickersham says, "No means are known whereby the faculties of the mind can be developed but by exercising them. By the potent spell of the magic word 'Exercise', is evoked all human power."

A true mathematical mind can think rationally and judiciously. Mathematics has immense contribution to culture. Mathematics has rightly been termed as the mirror of civilisation.

"Modern civilisation owes its advancement to the progress of various occupations such as agriculture, engineering, surveying, medicine, industry, navigation, railroad, building etc. These occupations build up culture and they are its backbone. But one should not forget that mathematics contributes and has contributed extensively to the advancement of these occupations. Therefore, mathematics shapes culture as a playback pioneer. Perhaps, the modern materialistic attitude in everything is the outcome of the deep influence of mathematics on life and culture."

9
SECTION II

SCOPE OF SCHOOL MATHEMATICS
The scope of schools mathematics encompasses emphasising the need for exactitude and quantification in the various school subjects; so that mathematics teachers can convince their students that mathematics is relevant to the study of all school subjects; and convince their colleagues of the other school subjects, that they too can utilise mathematics to provide quantitative foundations and precision to their subjects.

Essentially, the scope of the programme is to strengthen inter-disciplinary co-operation, to high-light the role of mathematics in all walks of life and to generate mathematical consciousness amongst the citizens who will not be afraid to use figures and quantitative data when it is appropriate to do so. The goal is to restore mathematics to its core position in the curriculum.

MATHMATICS AND OTHER SUBJECTS

Mathematics and Physics

Jagat Narayan Kapur in his article 'Mathematics In Other Subjects', has stated;

"Most of our contemporary mathematics was generated in a physical context. It was created in the solving of problems of physics. Consequently, physics provides the greatest stock of examples to illustrate and to motivate mathematical concepts". 
The periodic phenomena in physics like simple harmonic motion can be understood through mathematics. They include the propagation of waves in water, of light, sound or electronic waves, the production of sound as in making music etc. All these make use of the simplest periodic functions, the sine and cosine functions. This shows that the applications of trigonometric functions in discussions of periodic phenomena is of greater importance than their applications to heights, distances and surveying. Perhaps no other science is as close to mathematics as physics is.

For higher education in physics, it is very helpful to possess a good qualification in mathematics. Only a mathematical mind can take up the study of physics with confidence. Every rule and principle ultimately assumes a mathematical form. Mathematics gives the final shape to the principles of physics. Mathematical calculations occur at every step in physics.

**Mathematics and Chemistry**

"All chemical combinations and their equations are governed by certain mathematical laws. Formation of chemical compounds is governed by mathematical calculation".

In the manufacture of every chemical, there is a particular chemical ratio in which different elements have to be mixed.
"In this atomic age, atom ceases to be the smallest indivisible particle of matter. The atom is a composite of many smaller particles like neutrons, protons and electrons. A slight disturbance in their balance produces tremendous energy. Harnessing this energy requires quantitative interpretation of change of form of energy. These equations and interpretations are provided by mathematics."12

All explanations relating to synergetics require a knowledge of high-level sophisticated mathematics.

Mathematics and Biology

"The old fallacy - that there is no meaningful interaction between mathematics and biology - has been completely exploded now that agriculture, biological and medical scientists are employing mathematics, statistics and computers on a large scale and since mathematicians, statisticians and engineers need to possess a good knowledge of biology to be able to contribute to genetics, to population dynamics, biofluid dynamics, agricultural statistics, biomedical engineering etc."13

One of the most fascinating application of mathematics is to human physiology itself. Mathematics is needed to know the volume of blood in human body, total length, surface area and volume of all blood vessels, total number of red blood corpuscles and weight, amount of oxygen we breathe, number of air sacs in the lungs etc.

Mathematics and Geography and Astronomy

"Geographical map-making is essentially a mathematical problem, though it sometimes involves college-level mathematics. Secondary school students can be taken as far as possible in the principles of geographical map-making, and can be motivated to
learn higher mathematics to achieve particular projections. We can have maps which show distances accurately, or angles accurately or areas accurately. These may be called geometrical maps. We can also have population maps, or economic resources maps.

It requires a great mathematical ingenuity to construct the maps showing per capita income of a country in comparison to other countries; and also population charts showing size of the country and the proportional figures of population.

"Astronomy fascinates school students and many of its truths can be easily explained mathematically to students. Thus, knowing only a few observational facts, students can find out the masses and the distances of planets and of the moon, and discuss methods of finding the distances of stars." 15

Mathematics and Social Sciences
(History, Civics, Economics and Commerce)

Representing historical data of the regions of kings and of dynasties by bar charts and histograms can give useful insights to students. The students may also try to represent quantitatively economic and social conditions in different periods of history.

In politics, the strength of various corporations legislative assemblies, houses of parliament and of different combinations in voting and data on elections at various levels, etc. can provide many fascinating mathematical problems which may appear relevant to the politically conscious students of to-day.
The economic development of a country during the last two or three decades can only be highlighted through numerical data and its graphical representation. The results of mathematics are developed through a process of reasoning. There are only a few premises on which the reasoning is based. The conclusion follow naturally from the given facts when logical reasoning is applied to the same. The reasoning in mathematics is of a peculiar kind and possesses a number of characteristics such as similarity, accuracy, certainty of results, originality, similarity to the reasoning of life and verification.

"To-day we are under great pressure to teach more mathematics to students at an earlier age because of the steady growth in the applications of mathematics. At the same time we are more sensitive to the psychology of learning related to mathematics about which, however, our knowledge is limited. These factors make the problem of compiling a mathematical syllabus a very complex one. On the other hand we have a greater understanding and deeper insight into the concepts and theories of contemporary mathematics. It is this aspect of modern mathematics which places us in a good position to produce a unified syllabus."

Mathematics plays a predominant role in our everyday life. It has become an indispensable factor for the progress of our present day world. It is the pivot of all civilisations. Everybody has to calculate his income and balance his family budget, although a few of them undergo any of the university courses. This is the subject which indisputably forms the very basis of entire world's commercial system. It is the contributory
factor in the prosperity of human race. There is no science no art and no profession, where mathematics does not hold a key position. The accuracy and exactness of a science is determined to a major extent by the amount of mathematics utilised in it. Every social science like economics, psychology, geography etc. makes abundant use of mathematics. The gigantic works of construction of dams, bridges, other works of architecture, building of ships, aeroplanes, bombs etc. are possible only because of the quantitative science. Even medical men have to measure the doses, the blood pressure the beat of the pulse, the body temperature etc. Most of the natural sciences; and even philosophy, are to be studied on mathematical lines; and without the study of mathematics there would be no improvement in them.

"When we come to examine the question of real reason for the study of mathematics today, we find that we seek a receding and an intangible something which quite baffles our attempts at capture. Indeed, we may rather congratulate ourselves that this is the case, and say with one of our contemporary educators, "For one, I am glad, we cannot express either quantitatively or qualitatively the precise educational value of any study."17

Of course, the trend from applied to theoretical science appears in ancient history as well as in many contributions to modern mathematics by engineers and physicists. In the nineteenth century imminent need for consolidation and the desire for more security in the extension of higher
learning that was prompted by the French revolution, inevitably led back to a revision of the foundations of the new mathematics. Thus the Nineteenth Century was not only a period of new advances, but was also characterised by a successful return to the classical ideal of precision and rigorous proof.

According to the Education Commission of India, 1964-66:

"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 century marks the beginning of the new scientific - industrial revolution and makes it all the more imperative that special attention be devoted to the study of mathematics. Proper functions in the knowledge of the subject should be laid at school."  

Mathematics is the systematised, organised and exact branch of science. It deals with quantitative facts and relations as well as with problems involving space and form.

Mathematics studies nothing but pure hypotheses and is highly abstract in its nature.

"Mathematics now began to be looked upon as a subject not for the scientist and the merchant only, but for the soldier, the priest, the labourer, the lawyer and generally for men in all walks of life, and a subject valuable in various ways in the mental equipment of the youth. It has to train for business, but not that alone; to be interesting, but not that alone; to train the child to accuracy, to correlate with other subjects, to pave the way for science, but none of these alone."
It may be briefly stated that the importance of mathematics can be reinforced through a variety of theoretical and practical imperatives like disciplining of the intellect, and contribution to the promotion of culture.

Teaching of mathematics must be based on a sound value-system and a proper understanding of its aims.

"The direct utilitarian value of mathematics - its value to the breadwinner - has been much over-estimated; or, perhaps, it is nearer the truth to say that, while accuracy and speed in simple fundamental processes have been underestimated, the value of presenting numerous and varied themes in pure mathematics, and of pressing each to great and difficult lengths, has been seriously over-rated."  

It cannot be denied that the modern civilisation owes its peculiar stamp indirectly to mathematics. Whenever there is any activity there is mathematics.

"It is an admitted fact that widespread are the applications of mathematics and enormous is its practical value. The use of mathematics in our daily life is immense."  

The emerging challenges of development can be analysed and solved only with the help of an adequate quantified data-base. The intricate actuarial calculations and those associated with modern banking, company-law administration and fiscal administration necessitate a profound and practical understanding of mathematics.
Mathematics and Language Arts, Crafts and Sports

Students can determine the relative frequencies of use on various pages of their textbooks of the various letters of the alphabets or groups of these letters such as dipthongs and discuss their stability. They can also compare mathematically the styles of various authors. This can provide a motivation for learning some probability theory, statistics, information theory, mathematical linguistics, codes and ciphers.

The knowledge of projective and information theory can be of great value in the study of painting, sculpture, and architecture. The seven groups of symmetries of the broader design and the various groups of symmetries of polygon and polyhedra can give an additional dimension to the study of commercial art.

Various technical crafts depend heavily on school mathematics and interesting examples can be cited.

Sports is an activity very dear to the hearts of the students. Even in games and sports there is the hidden interplay of certain basic principles of arithmetic, algebra, geometry, probability, statistics and graph theory which can be highlighted through a variety of examples.

Mathematics and Ethics

George David Birkhoff in his article 'A Mathematical Approach to Ethics', has expressed his views that for certain
purposes philosophic thought may be treated separately in its logical, aesthetic, and ethical aspects concerned respectively with the true, the beautiful and the good. Logic has developed into an independent discipline - the edifice of symbolic thought - of which all the mathematics appears as the grandiose superstructure. According to him:

"More specifically, social customs and systems of law and of religion contain a vast mass of ethical data, embodying the accepted ethical solutions of innumerable practical problems of analytic ethics; and the inductive method can generally be applied to treat new problems when they arise. In so far as these solutions are not purely empirical, they could be codified by means of the ethical formula. Such a codification would list and classify the very extensive variety of ethical intuition (postulates), in part the cause of, and in part the result of, specific social interactions. There is little doubt of the basic role which the sentiments of love, good will, loyalty, and other feelings of sensuous, aesthetic, or intellectual type play in such intuitions. These provide a substratum of absolute elements, of which the specific manifestation depends on the particular culture and period concerned." 22

Mathematics and Amusement

All branches of knowledge have been influenced by mathematics. Even in day to day life, in leisure time gossips and amusement the unseen presence of mathematics is very much there.

"Games and puzzles are the subject of a considerable mathematical literature, much of which is both difficult and tedious. The writings on magic squares alone suffice to make a fair-sized library. Nothing more dismal can be imagined. It is not inevitable that the mathematical treatment of games
should work a blight. Games are among the most interesting creations of the human mind, and the analysis of their structure is full of adventure and surprises. Unfortunately there is never a lack of mathematicians for the job of transforming delectable ingredients into a dish that tastes like a damp blanket."23
SECTION III

CURRICULUM
The word curriculum comes from a Latin root meaning 'racecourse' and traditionally the schools' curriculum has represented something like that figuratively, speaking of course - to most people. Indeed, until quite recently, even the most knowledgeable professional educators regard curriculum as the relatively standardised ground covered by students in their race towards the finish line (a certificate). It should not be a surprise, then, to find that many current concepts of the curriculum are grounded firmly in this notion that curriculum is a race course of subject-matters to be mastered. Denis Lawton has expressed his view on curriculum as:

"There are at least two views on the meaning that can be attached to the word 'curriculum'. One view which was until recently generally accepted, was that the curriculum of a school was what was officially taught as lessons. According to this view, if you wanted to know about the school curriculum you would look carefully at the time-table. This meaning of curriculum has its attractions, not least in its clarity and simplicity, but it has also led to certain kind of confusion. Sometimes suggestions have been made (for example in the Newsom Report) that certain extracurricular activities were so important that they should be made compulsory for all pupils. So when does an extracurricular activity become part of the curriculum? Is it when it appears on the time-table? Or when it is compulsory or when it can be defined as lesson?"

Another disadvantage of the way limited but precise view of "curriculum" as 'time-table' is that many educationists would suggest that often the most important aspect of an educational programme are not included in the time-table at all, and only a very naive person would confine his investigation of a school's curriculum to a look at the time-table. Some educationists have also been driven to the inventing
the term 'the hidden curriculum' to convey the idea that some school activities, such as the prefect system or the cadet corps, are very powerful and influential but would not appear on the time-table as curriculum. Thus some writers (Kerr, 1968) would want curriculum to be used in a much wider sense; 'All the learning which is planned or guided by the school, whether it is carried on in groups or individually inside or outside the school'.

Curriculum is not just the list of subjects and topics to be covered within a definite period of time. It is something more. The learning experiences of pupils gained through activities inside or outside the school under its direction is considered as curricular activities.

A curriculum conceived of as planned learning experiences is one of the most prevalent concepts among specialists. For example Krug refers to curriculum as

"All the means employed by the School to provide students with opportunities for desirable learning experiences."

Trying to give a more precise definition to curriculum, Zias has accepted the views of Doll (1964 P.15),

"The commonly accepted definition of the curriculum has changed from content of courses of study and list of subject-courses to all the experiences which are offered to learners under the auspices or direction of the school."

Thus the word curriculum has wider meaning than the list of contents to be covered. It included all the learning
experiences of the pupils under the jurisdiction of the school's programme.

W.K. Richmond has listed some definitions of curriculum in his book 'The School Curriculum'.

1. "All the learning which is planned or guided by the school, whether it is carried on in groups or individually inside or outside the school" (John F. Kerr)

2. "That the curriculum consists of content, teaching methods and purpose may in its rough and ready way be a sufficient definition with which to start. These three dimensions interacting are the operational curriculum". (Phillip H. Taylor)

3. "The programme of activities designed so that pupils will attain as far as possible, certain educational ends or objectives". (Paul Hirst)

4. "The contrived activity and experience - organised, focused, systematic - that life, unaided would not provide ......... It is properly artificial, selecting, organising, elaborating and spreading up the processes of real life. (Frank Musgrove)"

From the above definitions it can be concluded that the curriculum of a school is both intended and operational to bring about modification for the process of real life.

The child-centred curriculum advocated by Rousseau has ushered in its wake a series of cataclysmic changes in the entire school system; and the most to be effected is the curriculum and its delivery system - the methodology. Education is the means for effecting wholesome development of the child's
personality; and that had inadvertently been forgotten by discipline-loving school-masters while handling a boisterous crowd of living children bubbling with enthusiasm and mischief. Internalization of the ideas and their organic absorption in the behavioural pattern has been the desiderata. The awakening of the mental powers, sharpening the intellect and profuse provision of information on various subjects is important in only so far that these may be able to subserve the higher ends of education viz. the bringing about an appreciable improvement in the quality of life of the several millions of students under the change of the schools. Subject-matter is but spiritual food, possible nutritive material. It cannot digest itself; it cannot of its own accord turn into bone and muscle and blood. If the life and experience of the child are made subservient to the procrustean demand of the curriculum, then the schools are sure to degenerate into shops of mechanical drilling and penal places for the pupils.

Therefore, curriculum is "the sum total of student activities which the school sponsors for the purpose of achieving its objectives - will be influenced by the values held by those who determine what shall be taught."28

Some writers who favour the broader definition of the curriculum sometimes refer to the 'invisible curriculum' or the 'hidden curriculum' i.e., those aspects of curriculum that are unplanned or unintended, and therefore, overlooked. The
Figure 1 A representation of the Mathematical Association Everyman syllabus.

(Source: P.G. Dean, Teaching and Learning Mathematics P.179)
experiences that the students actually will have as they interact with the curriculum cannot be known.

Thus the definition, 'curriculum as a structured series of intended learning outcomes', does not include some aspects of experiences through the interaction of the individuals with curriculum which are not known and cannot be assessed.

All the discussions on curriculum are the expectations but in usual practice there is something else which has been rightly pointed out by Hooper Richard:

"The way we set about designing curriculum follows logically from what we think curriculum is. A narrow definition of curriculum - to mean just subject matter or content - still is found in academic reaches of the educational system. The university teacher is intent on covering all the main points of a particular topic. In both cases the statement of the content is the statement of the teaching objectives. As a result the learner is often expected to do little more than memorise the content to which he is exposed and recall it for the shake of examinations.

These four basic elements of curriculum - objectives, content, methods, evaluation - do not constitute neat, discrete categories. They are closely interrelated and each element is influenced and influences the others. The curriculum constitutes a 'system' and curriculum development is in one sense a form of 'system analysis'. Education and curriculum within it has a set of inputs, which are subject to a process in order to attain outputs which are intended to satisfy the system's objectives. These form a dynamic, organic whole. And if one is to assess the health of an educational system in order to improve its performance and to plan in future intelligently, the relationship between its critical components must be examined in a unified vision."
SECTION IV

MATHEMATICS CURRICULUM
An outstanding mathematician once said, "One can teach anything to children, even false ideas, but only for a while. Nothing will become lasting and useful knowledge unless it is rooted in ideas familiar to children, connected with their range of thought." 30

Any effort which is made intelligently will aim at certain results. If instruction in mathematics is to be worthwhile, it must be planned with the idea of achieving certain aims which represent values attainable from its study. Therefore, it is possible to set up a rational criterion for determining suitable and useful content of mathematics courses.

Mathematics is a subject full of abstractions. To concretise the abstract ideas in the minds of the pupils is a difficult task.

"We know that everyday life has been changing, and that the curriculum has also been changing. It would be wrong to imagine that the nature of mathematics, or at least our view of that nature, has remained fixed. It has been widely suggested that there are eight forces which influence and activate mathematical evolution, (1) cultural stress, both environmental and hereditary .... (2) symbolization, (3) diffusion, in the anthropological sense, (4) abstraction, (5) generalization, (6) consolidation and diversification, (7) cultural lag and resistance, and (8) a process of selection." 31

Out of these only three are mathematically most important, namely, generalisation, abstraction and symbolism.
"Mathematics is not only a body of theorems and problems. To it belong also definitions and axioms, notations and terminology. In an up-to-date teaching of mathematics pupils learn not only names and symbols for mathematical entities, but also to name and to symbolise. Searching for a better name or symbol than that accepted by others is just as important as adopting themselves to standards and common usage. The same applies to forming concepts or to adopting axioms. Weighing the relative merits of various definitions or axioms, names or symbols in an important mathematical activity, even though it does not belong to formal mathematics."32

Generalisation is the process by which a mathematician passes from understanding one structure to understanding another structure which subsumes the former as a part; or it is the statement that certain structures have a particular property which can be extended to a finite or infinite number of other structures. An application in school is that pupils may be encouraged to use an abacus when learning to understand the addition and subtraction of small whole numbers and then help them to build up a more general understanding of the denary system of numbers.

Abstraction is the process of identifying the essential core in one more mathematical structures by ignoring the details which are, in some sense, superfluous. Once this essential core has been studied to discover its mathematical properties, the results can be applied to any other structure which has the same essential core. In schools, pupils use sets of mathematical shapes, equations, etc., which provide many opportunities for them to practice abstraction.
"Abstraction provides a 'shortcut' to the frontiers of knowledge, by furnishing the means to incorporate within a single theory a number of special cases and by focusing attention on those features which seem to be essential and suppressing those which are superficial. Moreover, it is the abstract character of mathematics that makes possible its application to problems in a wide variety of fields outside mathematics. But it is precisely here that the educational problems arise, for such applications bring with them a demand for high level of mathematical literacy amongst an increasingly large proportion of students; and for many of these students abstract mathematics is uncongenial and perhaps even inaccessible."

Symbolism is a way in which the processes like generalisation and abstraction can be carried out, using rules to manipulate defined symbols. Mathematical symbols, which include words, figures and special signs, are also used to communicate messages to other people; and most of the educated people are familiar with this on work sheets or in text-books. Nearly everybody should be able to read, speak and understand these symbols which occur in their everyday life. It has already been said that mathematics should be considered as a changing subject and the symbols in use today have developed over the centuries to meet the sophisticated requirements of developing mathematical and evolving society. If the pupils study these changes, they may be able to understand the nature today's mathematics.

The curriculum in mathematics should provide adequate scope to pupils to learn abstractions of mathematics with interest. The topics included in mathematics curriculum should
not necessarily be examination subjects or opportunity offers. But the intention should be concerned with pupils’ appreciation of and attitude to mathematics.

The International Commission on Mathematics Education had said,

"As a reaction to the highly abstract courses of recent years, it is becoming more common to find syllabuses for the senior high school in which there is a more concrete, process-oriented programme of mathematics until the final year, when an attempt is made to summarize and show the connections in what has been learnt, from a more abstract point of view."34
SECTION V

DESIGN OF THE STUDY

(a) Statement of the Problem
(b) Definitions
(c) Need
(d) Objectives
(e) Scope
(f) Limitations
(g) Related Studies
(h) Methods of the Study
(a) STATEMENT OF THE PROBLEM

The present study is concerned with the critical appraisal of the present secondary school mathematics curriculum of Orissa. The problem is stated as: "A CRITICAL APPRAISAL OF THE SECONDARY SCHOOL MATHEMATICS CURRICULUM OF ORISSA."

(b) DEFINITIONS OF THE TERMS USED

Different words have their different connotations according to their place of reference. It is essential for the investigator to define or explain the words which are used repeatedly in this research. Some of the terms used are:

i. Critical

In Chambers Twentieth Century Dictionary (1978), the word 'critical' has been defined as "fault-finding" or "relating to criticism". Here the researcher is interested to find out faults of the existing curriculum in mathematics at the secondary school stage.

ii. Appraisal

In the same dictionary the word 'appraise' means "to estimate the worth of something." For the purpose of this study the researcher used the meaning to find out relative weightage or value of the different aspects of the curriculum in mathematics. The aspects were objectives of teaching mathematics, contents, teaching methods, teaching aids and valuation.
iii. **Secondary School**

The secondary school of Orissa means three classes i.e., Class VIII, Class IX and class X. The study was confined to these three classes only. It is the education imparted to the age-group 13+ to 15+.

iv. **Curriculum**

The word curriculum conveys the meaning 'a course' or "the courses of study" according to the Chambers Twentieth Century Dictionary. But the educators attach wider meaning to the word 'curriculum'. It had already been discussed earlier. However, a single definition will serve the purpose. Cunningham defines curriculum as "a tool in the hands of an artist (teacher) to mould his material (the pupil) according to his ideals (objectives) in his studio (school)".

v. **Mathematics Curriculum**

In the context of this study, Mathematics Curriculum means the curriculum of Compulsory Mathematics prescribed for classes VIII, IX & X by the Board of Secondary Education, Orissa.

vi. **Board of Secondary Education, Orissa**

The Board of Secondary Education, Orissa was constituted as per the provisions of the Orissa Secondary Education Act 1953 (Orissa Act X of 1953) to regulate, control and develop secondary education in the State of Orissa. It was constituted in

It prescribes the courses of instruction for the secondary schools and such other institutions for which it is made responsible by the Government of Orissa from time to time. It coordinates secondary education with University education on one side and Elementary education on the other. It prescribes the textbooks; conducts examination based on the courses prescribed by it; recognises the secondary schools and other institutions for which it is made responsible; admits candidates to its examinations, publishes its results, grants certificates to successful candidates.

It is the apex body in so far as secondary education is concerned in the State of Orissa.

vii. Orissa State

It is one of the 25 states and 7 Union Territories that constitute the Union of India. It was carved out as a separate State with effect from 1st April 1936. It has an area of 1,55,707 square kilometers and a total population of 2,63,70,271. Administratively it is divided into 13 revenue districts and 57 sub-divisions. There are 29 towns, 71 Notified Area Councils and 50,887 villages. It lies between 17°49' and 22°44' Northern
FIGURE 2

MAP OF NIDIA SHOWING THE LOCATION OF ORISSA

AFGHANISTAN
PAKISTAN

BOMBAY
RABIAN SEA

DELHI

CHINA
TIBET
NEPAL
BHUTAN
BANGLADESH
CALCUTTA

ORISSA
BHUBANESWAR

BAY OF BENGAL

MADRAS
SRI LANKA

INDIAN OCEAN
FIGURE 3
MAP OF ORISSA SHOWING THE
DISTRICTS

BAY OF
BENGAL

MADHYA PRADESH

N. BENGAL
BALASORE
CUTTACK
KEONTHAR
DHNKANAL
ANURAPUR
PHULABADIM
BALANGIR
GANTAM
SAMBHALPUR
SAMHAR
SUNDARGHARH
MAYURI BHANT
KORAPUT
CALAHAM
Bhubaneswar
Puri
Bhubaneswar
MADHYA PRADESH

N
W
E
latitudes 81°27' and 87°27' Eastern longitudes. It is bounded by the States of West Bengal on the north-east, Bihar on the north, Madhya Pradesh on the west, Andhra Pradesh on the south and the Bay of Bengal on the east. Area-wise it is the 10th state of the Indian Union; and occupies the 11th position in respect of population. Its capital is Bhubaneswar. It is mainly an agricultural state with preponderant rural population.

(c) NEED FOR RESEARCH IN MATHEMATICS CURRICULUM.

Mathematics is a live, expanding, developing subject to which people of varying ability and attainments, having received necessary training, can contribute in their subsequent careers. Most teachers already realise that the present context of school mathematics does not differ in any marked degree from that which was taught at the beginning of the century. It is a matter of some urgency that there should be a considerable re-thinking of the matter taught and its treatment.

Secondary Education Commission of India (1952) under the chairmanship of Dr. Laxmanswami Mudaliar, had opined that:

"For many decades there has been a strong and persistent criticism of the existing Secondary School Curriculum. During the course of our investigation we heard these criticisms repeated over and over again. The main points of criticism are that

i) The present curriculum is narrowly conceived;

ii) it is bookish and theoretical;

iii) it is overcrowded, without providing rich and significant contents;
iv) it makes inadequate provision for practical and other kinds of activities which should reasonably find room in it, if it is to calculate the whole of the personality;

v) it does not cater to the various needs and capacities of the adolescents;

vi) it is dominated too much by examinations; and

vii) it does not include technical and vocational subjects which are so necessary for training the students to take part in the industrial and economic development of the country. 39

Secondary school curriculum has become unduly bookish, theoretical and deals largely with abstractions and generalisations. At the high school stage a different approach is definitely needed. The high school pupils do not yet possess the intellectual maturity to deal completely with abstract theories and generalisation. The Commission had added that,

"Only the curricular content is justifiable in schools which adds to the understanding or the appreciation for the efficiency of students and can be grasped by them intelligently, pleasantly, and with a clear realisation that in some way, it is contributing to the enrichment of their life and activities. 40

The present secondary school curriculum in mathematics seems defective in all respects - with respect to the aims of teaching, the content, the methods of teaching, facilities available in the school, and even the procedure of evaluation. In this connection the remarks of the Southampton Mathematical Conference, under the chairmanship of Bryan Thwaites are apposite,

"In general, we feel that there is an essential need for improvement in the matter of achieving an integrated attitude towards mathematics by the pupils, and that many of their teachers find themselves ill-equipped to help them towards it. So we have
considered suggestions for keeping teachers up to
date both in their view of the subject as a whole
and in their knowledge of its various applications."

In order to make the learning of mathematics meaningful
to the pupils, the curriculum should be improved. Through the
improved curricula, the pupils will find pleasure in learning
mathematics — a subject of high abstractions and generalisations.
Only the bookish knowledge cannot satisfy the pupils. Learning
situations should be stimulating. Both classroom teaching and
teaching materials are to be organised in such a manner as to
create a congenial atmosphere for pupils to learn the subject.

Within recent years the Indian schools and colleges
have experienced substantial growth. The number of schools
and colleges have multiplied. Without question, educational
opportunities will continue to develop to meet societal needs.
Higher education specially in the field of science and technology
is being sought for larger number of younger people. Without
adequate knowledge of mathematics it is impossible to pursue
higher studies and to cope with the demands of the subjects.
This necessitates the updating of the curriculum.

NEED FOR THE PRESENT STUDY

The researcher was a teacher of mathematics at the
secondary school stage for a period of eight years. His own
difficulties and his past experience inspired him to undertake
research in the field.
The conventional approach to mathematics teaching is to equip a child with certain skills which is inadequate, as it fails to provide an insight into the correct understanding of mathematics, its logical structure to determine what should be taught in mathematics. The different branches of mathematics like arithmetic, algebra and geometry need to be harmoniously integrated and interrelated and teaching should aim at the development of mathematical models according to the changes in physical situations. Intellectualization, insightful thought and imagination tempered with precision, clarity and accuracy are essential in the field of mathematics compared to other fields of thought.

Therefore, reorganisation of mathematics curriculum is important.

Government of India and the several state Governments are keen to raise the standard of mathematics education in schools to attain parity, in this field, with other advanced countries of the world. Several projects have been undertaken by the Government through the National Council of Educational Research and Training. They are:

1. In 1962, a Textbook Panel was setup which prepared some material for primary and secondary schools.

2. In 1965, the above panel was replaced by an Editorial Board which had prepared textbooks and teachers' guides on several subjects for different classes.
3. In 1966, six Study Groups were setup to prepare detailed curricular guides useful for teachers as well as for authors and also to write textbooks for classes I - X. Each group was working under the guidance of a Director (a University Professor) with a Reader as whole time worker, two lecturers and two teachers as parttime workers in order to prepare material to bring the standard up-to-date.

4. Under another project with UNESCO assistance, textbooks, teachers' guides and curriculum guides for classes VI - VIII are being developed in the department of science education.

Besides these major projects, the Government of India as well as the several State Governments have been organising Summer Institutes, Short Courses, In-service programmes for teachers with a view to overhaul the existing system of mathematics teaching.

For upgrading the school curriculum, a number of important steps have to be taken. The most important one is the research in curriculum.

Systematic curricular research is needed so that the revision of the curriculum may be worked out as a well co-ordinated programme of improvement on the basis of the findings, instead of being rushed through haphazardly and in a piece-meal fashion, as often happens in many states of the country today. In this state, Orissa, no systematic study in the field of mathematics curriculum has been attempted so far.
Most of the curricular revisions attempted so far have been of an ad hoc character - not generally preceded by careful research, not based on adequate expertise and not followed by such necessary supporting measures as the preparation of learning materials, the orientation of teachers or the provision of the needed physical facilities. What is worse, the curricula are prepared at the state level and are prescribed uniformly for all the schools in the state. Such a procedure negates the freedom of the teachers and renders experimental work almost impossible. It also makes curricular revision very difficult and infrequent. This problem which faces education at all stages is particularly acute at the school level.

Before updating the school mathematics curricula it is essential to know the present status of mathematics in schools. No such investigation has so far been pursued by the State Govt. or the educationists. The researcher, who was a teacher in mathematics at the high school stage for some years, and is interested in highlighting the problems inherent in different aspects of mathematics curriculum prevailing in the State of Orissa.

Moreover mathematics greatly contributes to the percentage of failures at the High School Certificate Examinations. As such, almost all students at the secondary school stage run after private tuitions and personal coaching. Therefore, the question arises what makes mathematics so difficult? This requires an investigation into the curriculum of mathematics and hence this study.
(d) OBJECTIVES OF THE STUDY

The main objectives of the study were:

i. To analyse the objectives of teaching mathematics at the secondary school level from the point of view of the students, teachers and pedagogical literatures and to compare the objectives of teaching mathematics with that of curricula developed by the National Council of Educational Research and Training, Central Board of Secondary Education and the Indian Certificate of School Examination.

ii. To analyse the syllabus in mathematics from the point of view of students and teachers.

iii. To compare the syllabus in mathematics of Orissa with the syllabuses of N.C.E.R.T., I.C.S.E. and C.B.S.E.

iv. To analyse the present H.S.C. mathematics curriculum of Orissa to find out the relative importance of various topics.

v. To assess the present operational situations relating to the mathematics curriculum and to assess,

a) the textbooks that are prescribed and their adequacy,

b) the methodological approaches adopted for teaching the subject,

c) the procedure of valuation,

d) facilities available for teaching and the attitude of students in learning mathematics.
(e) SCOPE

Mathematics, as it is taught in the Indian secondary schools to-day, is neither a support for advanced studies and creative research in the field at the college and university levels; nor is it adequately utilitarian in its approach as to help the common man in his day to day life. It is in urgent need of complete reorientation. The isolation of the Indian secondary school curriculum from the international developments needs to be broken. Inter-state and international co-ordination is an educational imperative. We have, therefore, to adapt the education in our schools, colleges and universities to what is happening in other countries. Mathematics has greatly advanced than in any other curricular area of education. It is an international subject. The methods and techniques of mathematics are the same all the world over. Mathematical truths are the surest. The notations, symbols and the language of mathematics are the same for persons of all races, all creeds, all religions and all languages. This very language of mathematics has now undergone a great change. For instance, say seventy or eighty years ago, the mathematics notations were used without explanations viz., minus, plus, into, division, greater than, less than etc. Now the language of mathematics is very frequently used by writers without defining what are the terms stand for. A person who does not know what these symbols stand for, cannot even understand the first page of a modern book. Development in other sciences to the high levels of
national expectations is impossible if mathematics curriculum is not updated and streamlined as it is basic to the development of all other sciences.

It is essential to sensitize the younger generation to mathematics so that they can effectively contribute to the fields of the scientific world in which they live in.

Unless a thorough enquiry into the state of present mathematics curriculum is undertaken, improvement or reorientation of the present curriculum is impossible. The textbooks on mathematics are nationalised i.e., published by the Board of Secondary Education, Orissa, on behalf of the Government of Orissa. But the treatment in class-rooms differs from school to school; and such operational curricular outcomes are differential and suffer from refractions wrought due to the varying capabilities of teachers and students.

This study is undertaken to investigate the defects in mathematics curriculum; and to provide suggestions so that remedial measures can be taken up by competent individuals and institutions.

(f) LIMITATIONS

The study is not self-sufficient in all respects. It has a number of limitations.
1. The universe of Secondary School of Orissa and mathematics teachers and students therein is too large; and so the coverage in entirety is beyond the capacity of any single individual researcher. Therefore, the researcher had to resort to sampling to elicit the opinion of the teachers and students for this study.

2. The researcher had the desire to compare the curriculum of Orissa with the curricula of different States of India. A number of letters and reminders were addressed to all the State Council of Educational Research and Training, all the Directorates of Education under the State Governments, all the Boards of Secondary Education, and all the State Institutes of Education of India. Most of them did not favour the researcher with a reply. Very few of them expressed their inability to send a copy of their syllabus. Therefore, the comparison was limited to the syllabi of Orissa with ICSE, N.C.E.R.T. and C.B.S.E. curricula only.

3. The tools used for the evaluation of curriculum were planned and prepared keeping in view the existing Curriculum in Mathematics of Orissa on the basis of the expert opinion of selected mathematics teachers, retired teachers and mathematics experts. Care was taken not to make the opinionnaire unwieldy. This might have defeated the purpose of the research.

4. The resources for such a study are inadequate in Orissa. There is evident dearth of teachers and experts who are specialists in "Curriculum Development". Inadequate literature pertaining
to this branch of study was a deterrent. Therefore, outside sources were tapped to collect reference materials and expert advice.

5. The researcher had chosen 500 teachers for his study. Out of them only 220 teachers responded. During analysis it was found that some teachers did not respond to a number of items; further some teachers had responded carelessly to some items. Such cases placed the researcher in a delicate situation and he had to draw the conclusions with great circumspection.

(g) RELATED STUDIES

A comprehensive survey of related literature has been attempted in chapter II.

(h) METHODS OF THE STUDY

The standard procedure for educational research were followed for this project. The details of the procedure followed are as under:

Survey and Collection of Related Information

The related literature was procured from libraries of the Government College, Bhadrak, S.C.E. R.T., Bhubaneswar, other colleges of the State and Universities of Orissa. Some books and journals were purchased out of the research fund granted to the research worker by the University Grants Commission, India. The necessary and relevant materials were collected from books,
journals and project reports in order to build up a theoretical framework for the study.

**Preparation of the Tools of Research and Collection of Data**

A preliminary plan of action was prepared by the researcher keeping in view the following points for his project.

a. Major aspects of the curriculum and their details.

b. Persons to be consulted for supplying necessary guidance and data.

c. Questions to be answered by the teachers and students for the problem.

d. Development of requisite questionnaires and opinionnaires.

The steps followed for developing the two questionnaires were as follows:

a. Planning the Questionnaires

b. Preparing the Questionnaires

c. Trying out the Questionnaires

d. Standardising the Questionnaires

Expert opinion and suggestions were sought for developing the questionnaires. Finally, the drafts of the questionnaires were prepared. Both the questionnaires were printed. The author took the pain to meet personally the teachers and students for the administration of the questionnaires. However, most of the teachers did not return them immediately. They retained the
questionnaires to provide their considered responses to the various items of the questionnaire. They promised to mail the same to the author after some time-gap. But the students' questionnaires were administered in the schools by the author.

**Analysis and Interpretation of Data**

The data were analysed and interpreted by the author and presented in the form of text, tables and figures. On the basis of factual information, observation and evidence, the conclusions and generalisations were drawn.

**Preparing the Research Report**

On the basis of guidelines for writing the research report, the following chapterisation was designed.

**A. Preliminary Section**

1. Title Page
2. Acknowledgement
3. Table of Content
4. List of tables
5. List of Figures

**B. Main Body of the Report**

Chapter I  Importance of Mathematics and Design of the study.

Chapter II  Review of Related Literature

SAMPLE

John W. Best had remarked;

"A population is any group of individuals that have one or more characteristics in common that are of interest to the researcher. The population may be all the individuals of a particular type, or a more restricted part of that group...... A sample is a small portion of a population selected for observation and analysis. By observing the characteristics of the sample, one can make certain inferences about the characteristics of the population from which it is drawn." 42

Therefore, a sample is the mirror of a research project. It represents the whole population. In the following Table 1.1, the sample of the Secondary School Mathematics Teachers of Orissa belonging to different districts is indicated.

<table>
<thead>
<tr>
<th>Type of Schools</th>
<th>Govt.</th>
<th>Aided</th>
<th>Unaided</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>URBAN (a) Boys' School.</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>(b) Girls' School.</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(c) Co-educational.</td>
<td>9</td>
<td>30</td>
<td>1</td>
<td>2</td>
<td>42</td>
</tr>
</tbody>
</table>
TABLE 1.1

RURAL (a) Boys' School.  
(b) Girls' School.  
(c) Co-educational.  

<table>
<thead>
<tr>
<th>Type of School</th>
<th>No. of Schools</th>
<th>No. of Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RURAL (a) Boys' School</td>
<td>4</td>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>(b) Girls' School</td>
<td>2</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>(c) Co-educational</td>
<td>6</td>
<td>63</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
<td>140</td>
<td>25</td>
</tr>
</tbody>
</table>

(Vide Question No.3 and 4 in the 'General Information about the school' section of the Teachers' Questionnaire)

TABLE 1.2

DISTRICT-WISE DISTRIBUTION OF SCHOOLS IN THE SAMPLE

<table>
<thead>
<tr>
<th>Districts</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balasore</td>
<td>48</td>
</tr>
<tr>
<td>Mayurbhanj</td>
<td>32</td>
</tr>
<tr>
<td>Keonjhar</td>
<td>28</td>
</tr>
<tr>
<td>Cuttack</td>
<td>52</td>
</tr>
<tr>
<td>Dhenkanal</td>
<td>30</td>
</tr>
<tr>
<td>Sundargarh</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>220</td>
</tr>
</tbody>
</table>

(Vide Question No.2 in the 'General Information about school' section of the Teachers' Questionnaire)

Out of 13 districts of Orissa 6 districts were chosen for the study.

Table 1.1 and 1.2 represent the districts and types of schools from which the sample of teachers were chosen for the study.
### TABLE 1.3

**MATURITY OF THE SCHOOLS**  
(YEAR OF ESTABLISHMENT OF SCHOOLS)

<table>
<thead>
<tr>
<th>Year of establishment</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>3</td>
</tr>
<tr>
<td>1935 - 1939</td>
<td>4</td>
</tr>
<tr>
<td>1940 - 1944</td>
<td>5</td>
</tr>
<tr>
<td>1945 - 1949</td>
<td>0</td>
</tr>
<tr>
<td>1950 - 1954</td>
<td>5</td>
</tr>
<tr>
<td>1955 - 1959</td>
<td>12</td>
</tr>
<tr>
<td>1960 - 1964</td>
<td>37</td>
</tr>
<tr>
<td>1965 - 1969</td>
<td>53</td>
</tr>
<tr>
<td>1970 - 1974</td>
<td>38</td>
</tr>
<tr>
<td>1975 - 1979</td>
<td>42</td>
</tr>
<tr>
<td>1980 - 1984</td>
<td>21</td>
</tr>
</tbody>
</table>

**TOTAL** 220

(Vide Question No. 5 in the General Information about the school' section of the Teachers' Questionnaire)

The Table 1.3 represents the year of establishment of the schools from which sample of teachers was chosen for the study.

### TABLE 1.4

**STRUCTURE OF THE SCHOOLS**

<table>
<thead>
<tr>
<th>Classes included</th>
<th>No. of schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I to X</td>
<td>5</td>
</tr>
<tr>
<td>IV to X</td>
<td>21</td>
</tr>
<tr>
<td>VI to X</td>
<td>24</td>
</tr>
<tr>
<td>VIII to X</td>
<td>170</td>
</tr>
</tbody>
</table>

**TOTAL** 220

(Vide Question No. 6 in the 'General Information about the School' section of the Teachers' Questionnaire)
Table 1.4 represents the number of classes in the schools from which sample of teachers were taken.

TABLE 1.5
SIZE OF THE SCHOOLS

<table>
<thead>
<tr>
<th>Student Strength</th>
<th>No. of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>380 - 409</td>
<td>5</td>
</tr>
<tr>
<td>350 - 379</td>
<td>4</td>
</tr>
<tr>
<td>320 - 349</td>
<td>6</td>
</tr>
<tr>
<td>290 - 319</td>
<td>5</td>
</tr>
<tr>
<td>260 - 289</td>
<td>0</td>
</tr>
<tr>
<td>230 - 259</td>
<td>11</td>
</tr>
<tr>
<td>200 - 229</td>
<td>19</td>
</tr>
<tr>
<td>170 - 199</td>
<td>5</td>
</tr>
<tr>
<td>140 - 169</td>
<td>26</td>
</tr>
<tr>
<td>110 - 139</td>
<td>29</td>
</tr>
<tr>
<td>80 - 109</td>
<td>74</td>
</tr>
<tr>
<td>50 - 79</td>
<td>36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>220</strong></td>
</tr>
</tbody>
</table>

(Vide question No. 7 in the 'General Information about the school' section of the Teachers' Questionnaire)

Table 1.5 represents student strength of the schools of the teachers constituting the sample.

TABLE 1.6
THE SAMPLE OF THE STUDENTS

<table>
<thead>
<tr>
<th>Districts</th>
<th>Bala</th>
<th>Mayur</th>
<th>Keon</th>
<th>Cutt</th>
<th>Dhenka</th>
<th>Sundar</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>URBAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys' School</td>
<td>36</td>
<td>20</td>
<td>17</td>
<td>34</td>
<td>20</td>
<td>19</td>
<td>146</td>
</tr>
<tr>
<td>Girls' School</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>RURAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys' School</td>
<td>64</td>
<td>44</td>
<td>31</td>
<td>65</td>
<td>40</td>
<td>38</td>
<td>282</td>
</tr>
<tr>
<td>Girls' School</td>
<td>16</td>
<td>11</td>
<td>17</td>
<td>22</td>
<td>11</td>
<td>12</td>
<td>89</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>122</strong></td>
<td><strong>82</strong></td>
<td><strong>71</strong></td>
<td><strong>130</strong></td>
<td><strong>76</strong></td>
<td><strong>75</strong></td>
<td><strong>556</strong></td>
</tr>
</tbody>
</table>

(Vide General Information of the Students' Questionnaire)
Table 1.6 represents the sample of the students on whom the questionnaires were administered.

It is psychologically established that the education of the parents has a decided influence on the academic performance of their children.

Therefore, an attempt had been made to ascertain the educational attainments of the fathers of the students of the sample through the questionnaire.

**TABLE 1.7**

**FATHERS' EDUCATION**

<table>
<thead>
<tr>
<th>Educational qualification of fathers</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>73</td>
</tr>
<tr>
<td>Up to Upper Primary (Class V)</td>
<td>101</td>
</tr>
<tr>
<td>Upto M.E. School stage (Class VII)</td>
<td>51</td>
</tr>
<tr>
<td>Upto High School stage (class XI)</td>
<td>141</td>
</tr>
<tr>
<td>Upto I.A./I.Sc./I.Com.</td>
<td>32</td>
</tr>
<tr>
<td>Upto B.A./B.Sc./B.Com.</td>
<td>105</td>
</tr>
<tr>
<td>Upto M.A./M.Sc./M.Com.</td>
<td>53</td>
</tr>
<tr>
<td>Total</td>
<td>556</td>
</tr>
</tbody>
</table>

(Vide General Information of the Students' Questionnaire)

Grades in which the sample of the students passed the Middle School Scholarship Examination.

**TABLE 1.8**

**GRADES IN WHICH PASSED**

<table>
<thead>
<tr>
<th>Grades</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>14</td>
</tr>
<tr>
<td>O</td>
<td>49</td>
</tr>
<tr>
<td>A</td>
<td>186</td>
</tr>
<tr>
<td>B</td>
<td>283</td>
</tr>
<tr>
<td>C</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>556</strong></td>
</tr>
</tbody>
</table>

(Vide General Information of the Students' Questionnaire)
The various alphabetical notations of grades have the following meanings.

Out of 550 marks,
0 grade - 380 and above
A grade - 60% and above
B grade - 50% and above
C grade - 30% and above
D grade - 85 marks in aggregate and above

The sample of 556 students belonging to the different classes fall into different age groups.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>278</td>
</tr>
<tr>
<td>16</td>
<td>156</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>14</td>
<td>92</td>
</tr>
<tr>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>556</strong></td>
</tr>
</tbody>
</table>

(Vide General Information of the Students' Questionnaire)

The sample of 556 students belong to different classes as shown in Table 1.10

<table>
<thead>
<tr>
<th>Classes</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>362</td>
</tr>
<tr>
<td>IX</td>
<td>143</td>
</tr>
<tr>
<td>VIII</td>
<td>51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>556</strong></td>
</tr>
</tbody>
</table>

(Vide General Information of the Students' Questionnaire)
METHODS OF COLLECTING DATA

The researcher followed Normative Survey Method for gathering data for this study i.e., what existed or what prevailed. The method explains itself with the present phenomena in terms of conditions, relationships, practices, beliefs, attitudes, processes, effects or trends. It is also called the descriptive survey, status normative or trend study. Three types of information are collected - what exists, what is wanted and how to get there - and is therefore highly purposive.

Characteristics

It distinguishes itself by gathering data from a relatively large number of cases, by being cross-sectional, by concerning itself with general statistics of population or a sample, by serving as the basis of fundamental research, by possessing various degrees of complexity, by being both qualitative and quantitative and by having a good range of phenomena as its subjects. It has proved itself of great value in advancing knowledge.

Major Steps

This study is a school survey. Therefore, it consists of the following steps:

1. Preparation of the Plans
2. Preparation of adequate tools
3. Gathering data
4. Preparation of the report
THE DATA GATHERING INSTRUMENTS

The Pupils' Questionnaire

The questionnaire for the pupils consisted of forty questions. Besides general information like pupil's name, school's name, age, sex, class and education of father, general directions were given to the pupils with necessary hints to respond the items in the questionnaire. The questionnaire was in Oriya, the mother-tongue of the students.

The following is the description of items contained in the questionnaire.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>Liking for mathematics</td>
</tr>
<tr>
<td>3 to 26</td>
<td>Topics liked and disliked including the way students read mathematics.</td>
</tr>
<tr>
<td>27 to 33</td>
<td>How do the teachers teach mathematics</td>
</tr>
<tr>
<td>34</td>
<td>Time devoted to subjects</td>
</tr>
<tr>
<td>35</td>
<td>Love for branches of mathematics</td>
</tr>
<tr>
<td>36</td>
<td>Mathematics in play</td>
</tr>
<tr>
<td>37</td>
<td>Mathematical models</td>
</tr>
<tr>
<td>38</td>
<td>Devotion to mathematics</td>
</tr>
<tr>
<td>39 to 40</td>
<td>Mathematics books</td>
</tr>
</tbody>
</table>

( Vide Appendix - A )
Teachers' Questionnaire

The teachers' questionnaire consisted of nine sections, besides a general letter to the teachers at the outset. Total number of items in the questionnaire was 113. The items of the questionnaire were mostly close-ended and a very few of them were open-ended. The Teachers' Questionnaire was in English. A brief description of the items is presented in the Table 1.12

<table>
<thead>
<tr>
<th>Section</th>
<th>Questions</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 to 16</td>
<td>General Information about the school.</td>
</tr>
<tr>
<td>2</td>
<td>1 to 5</td>
<td>Objectives of teaching Mathematics.</td>
</tr>
<tr>
<td>3</td>
<td>1 to 11</td>
<td>General Information on the Mathematics Books.</td>
</tr>
<tr>
<td>4</td>
<td>1 to 28</td>
<td>Style of Writing</td>
</tr>
<tr>
<td>5</td>
<td>1 to 19</td>
<td>Teaching</td>
</tr>
<tr>
<td>6</td>
<td>1 to 12</td>
<td>Examinations</td>
</tr>
<tr>
<td>7</td>
<td>1 to 12</td>
<td>Facilities</td>
</tr>
<tr>
<td>8</td>
<td>1 to 6</td>
<td>Valuation</td>
</tr>
<tr>
<td>9</td>
<td>1 to 4</td>
<td>Miscellaneous</td>
</tr>
</tbody>
</table>

(Vide Appendix - B )

Statistical Treatment

The data collected after administration of the questionnaires were classified and presented in tabular form.
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<table>
<thead>
<tr>
<th></th>
<th>Author(s)</th>
<th>Title</th>
<th>Publisher and Location</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>31</td>
<td>P. G. Dean</td>
<td>The Teaching and Learning Mathematics</td>
<td>Woburn Press, 1982, P. 98</td>
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<td>32</td>
<td>W. Servais and T. Verga</td>
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<td></td>
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<tr>
<td>33</td>
<td></td>
<td>New Trends in Teaching Mathematics</td>
<td>International Commission</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td></td>
<td>Op cit P. 61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td></td>
<td>Ibid P. 318</td>
<td></td>
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<tr>
<td>40</td>
<td></td>
<td>Ibid P. 75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>B. Thwaites</td>
<td>Op cit P. 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>J.W. Best and J.V. Kahn</td>
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<td></td>
</tr>
</tbody>
</table>