INTRODUCTION:

1.1 Importance of instructional methods in learning:

Our country is facing with a number of educational problems. In the present condition through which our nation is passing, we need some new methods of teaching which may prove useful to solve our problems. We have acute shortage of well qualified teachers in different subjects of secondary level. Our method is traditional which has become obsolete in the present era of development. Researches in methods of teaching school subjects Prof. N.P. Pillai has observed thus.

"In the field of teaching methodology we have so far been able only to search the surface of the problem and that too in a haphazard way. We are still confused about the realistic objectives of education in the period of transition. So far no consistent and concerted attempts have been made to coordinate research activity on education and methods of teaching in order to facilitate meaningful and intelligent communication not only between the research workers and men and women who are in contact with the problems, the teacher, the administrator and the educational policy makers but also among the investigators in the universities in India."*

Prof. N.P. Pillai has also suggested that the blind hit or miss attack on any target which has so long characterised our research activities has to be replaced by systematic attack on really significant problems against regional and national background.

According to Prof. B.F. Skinner, Harvard University - "The best way to teach students is to break the subject matter into meaningful full segments of information and to write small steps in such a way

* Aggrawal, J.C. Educational Research An Introduction, New Delhi, P-80-81.
that only correct reponses are likely to occur. Students learn better when they are successful. Students should be provided immediately the result of his performance. So, any way, methodology is what the instruction do in bringing about desired out come in and out of school situation."

Under our Indian system of education, the central Govt. through its agencies like CB.S.E., NCERT and U.G.C. as well as a number of committee and commissions that are appointed from time to time, lay down educational objectives and it is through state agencies like SCERT the curriculum planning has been done. This centralised model of curriculum planning has been in vogue in India for the last several decades. It is in fact a legacy of the British system of education. Their tradition of approach of teaching is still existing in our system of education in the name of traditional approach. In the present day context, new methodology should develop for better understanding and developing skill.

As the need and interest of the children and the problems of the society changes from time to time. There is need to develop a continuum in the process of learning. This includes the following - (1) Analysis of students' need and interest, (2) Formulation of instructional objectives. There is a great difference between traditional objectives and instructional objectives. Traditional objectives are usually supplied to the teacher in the beginning of the session in the book. They do not communicate the content of the course in term of behavioural out come. A good instructional objective may be defined as one that succeeds in communicating to the reader the programme on written instructional content in definite and precise language. The learning becomes more and more individualistic as the class strength becomes larger and larger in the present day population explosion. The individual difference is more pronounced in large group. There are best
learners and slow learners. Only effective teaching helps students what they can.

Since learning is highly individualistic, ideal teaching requires to be individualistic. Individualised instruction would help students do what they can in learning more than group instruction. Individualised instruction is instruction according to the requirement of the student's learning level, in terms of the learning style of the student and in terms of the motivation for learning. Now a days, more informations are to teach to more number of students and infact, never before in the history, the teachers of to-day have to teach so much to so many in so very highly individualistic manner. For this changes have to be brought in the instructional techniques. Teaching should adopt itself to the learner and the instructions require to be planned and programmed.

A programmed instruction is described more or less in general terms what is to be achieved by students (who are homogenous at least in respect of ages) in terms of instructional materials and instructional arrangements. All teachers are planning or programming their instruction with an average student in mind.

1.2 Mathematics as a subject of study:

"Mathematics is the technique of uncovering and conveying in the most economical possible way, useful rules of reliable reasoning about Calculation. Mathematics is more than a method, an art, a science and a languages. It is a body of knowledge with content which serves all type of human endeavour - be it politics, Business, Scientific Research, Technology, music etc." said by Dr. V.S.Venkatavardan. (2)

The knowledge explosion of mathematics in the present day

(2) Seshan V - Mathematics Education at School level. cenbosec - Qrly bulletin CBSE Vol 32 No. 3 Sept 1994 P-5-6.
world is tremendous. The increasing contribution of mathematics to the
culture of the modern world as well as its importance as a vital part
of scientific and humanistic education, has made it essential that
mathematics in our school be both well selected and well taught. In the
modern age, mathematics has become the backbone of the present system
of education. Mathematics is important not only because of its valuable
achievement rather it has become indispensable for our existence. It is
the only branch of education which can solve day to day problems of
this dynamic world with the harnessing of mathematical knowledge right
from the kitchen to our space. Our country is facing with a number of
educational problems which need immediate attention and appropriate
solution, otherwise there is every possibility that these problems will
become very difficult to control and to resolve them and will become
impracticable in the near future. The number of school going children
who have not been brought for schooling, is increasing every year. If
some daring effort by new introduction of new methods is not made the
problem will become insurmountable, teacher-student ratio is growing
high and it will increase in the future. In the words of J.W.A.
young:

"Wherever we turn in these days of iron, steam and electricity
we find mathematics has been the pioneer. Were its backbone removed,
our civilisation would inevitably collapse. The modern thought and
belief would have been altogether different had mathematics not made
the various sciences exact. The different laws of science and
scientific instruments are based on exact mathematical concepts.
Astronomy and physics are the most exact sciences and the exactness is
the result of the usefulness of mathematics" (3)

(3) Rai, B.C. - Methods of Teaching of Mathematics, Prakashan Kendra,
Lucknow - P-6.
Mathematics has grown as a tool of exact concepts, expanding man's knowledge and controlling the material world around him. It has followed a century long line of evolution, growing in complexity, because it has been used as a tool to do more and more complex tasks. Benjamin Rarrington has rightly said about the contribution of mathematics toward the development of science in the following words:

"Science as it progresses, makes for itself an equipment of concepts which are the tools by which it analyses the complex phenomena of experience. These mental tools, have their history like their material counterpart of stone and metal."

The study of mathematics involves understanding nature and applying it for the welfare of mankind. In a mathematics based world education, it is highly essential for the development processes of community for its progress and security. It is obvious that mathematics is the only branch of education which can meet our day to day's problem of this complex world society. It becomes absolutely necessary to consider the scope, function and implication of mathematics education at different levels in the context of our national requirement. From the third plan onwards high priority has been given to strengthen and modernise the structure of methodology of teaching mathematics in the secondary level. The NCERT, S.C.E.R.T. and UNICEF have joined hands and launched a number of schemes and programmes to bring about a revolution in the field of mathematics education.

Secondary education is the foundation stage of higher education. Every secondary school pupils should study elementary mathematics as a compulsory subject so that he gains a basic quantum of mathematical knowledge as a part of his general education. In addition, there is provision for providing elective subject in mathematics for those

students who want to pursue higher education. In this context, the new pattern of schooling as suggested by the education commission (1964-66) is worthwhile to mention. The aims and scopes of school mathematics as suggested by the Education Commission are:

"The teaching of mathematics should help in (a) the development of the power of logical thinking, (b) the understanding of the fundamental principles underlying the vocational tasks faced by mankind (c) the purposeful teaching to be developed so that the topic taught becomes functional to the life of the community (d) to develop the power of concentration of the mind of the pupils, (e) the motivation of the study to be stressed, (f) the development of the knowledge through the truth based on logic and to understand and control of the environment, (g) in cultivating the qualities of exactness in expression and performance and to develop administration for mathematics for its precision" (5)

And the Commission has suggested the following measures to be undertaken for the revision of curriculum of school mathematics:

1. The compartmentalisation of traditional Course of mathematics into arithmetic, algebra and geometry should go.

2. The unified approach of teaching mathematics should take place.

3. The development of number system, notation, equation, graph and function are to be included in the syllabus.

1.3 Mathematics and Instructional Method:

The learning of mathematics on the part of a pupil depends on how the subject is taught. Before a pupil enters the secondary school, he must learn arithmetic for four years. The effect of teaching

arithmetic during this period is more or less permanent on him. It creates a like or a dislike in him for the subject. To avoid this the instruction in the elementary school should be made more interesting and enjoyable.

Methods of the teaching of mathematics are guided by principles which form the basic of the method. In fact the principles are the basic requirements, that govern the teaching of the subject. Various principles are:

(a) Correlation of the subject matter with life.
(b) Knowledge of the importance and need of the subject matter.
(c) By putting some problem of every day life before the students.
(d) By awakening the natural tendency of the educand.
(e) Selection of the subject matter, keeping in view the intelligence, and psychological requirements of the students.
(f) Keeping the interest alive. 

According to Montessori "A wholesome human employment is the first and the best method of education, mental as well as bodily."

On the basis of the above principles, different methods of teaching mathematics, at the secondary level had been propounded. Those were (1) Inductive - deductive method (2) Analytic and synthetic method (3) Henrostic method (4) Lecture method and laboratory method. These methods were based on empirical to rational, concrete to abstract and self activity. The first two methods are suitable to teach

mathematics. The heuristics method is an experimental method not so suitable for teaching mathematics. There are again two approaches - Conventional approach and instructional approach. The conventional approach or traditional approach is the old teaching method where the knowledge aspect of the topic with given more stressed. Here everything was done after models "Model sums were worked out on the board and the pupils had merely to follow the pattern woe betide the pupil of the problem set for the examination did not conform to any one of the models taught in the school. Even now we do practically the same. (8).

The instructional approach is based on bloom's taxonomy. The instructional objectives at the secondary level are kn, un, application and skill. Teaching should be based on these objectives, different methods are used to realize these objectives while teaching a topic. But it a pity that the major objective of teaching to-day has been to teach the content matter and achieve the knowledge objective alone. Though it has been repeatedly stressed that the objective of teaching mathematics is to give conceptual understanding of the subject matter, the teacher tries to transmit a predetermined amount of knowledge or information to pupils under a formal system of schooling with the help of lecture method. There by pupils are required to learn what is taught to them by the teacher and give evidence of having learnt all that by passing an examination. (ref. the teaching of mathematics in the new education)

Individual difference:

The traditional approach does not consider the wide differences in abilities among children and adopt the teaching to the needs of individual. Modern psychology has brought out the fact that:

"The range of ability in school children of the same age is such that in a majority of capacities, the most gifted child will, in comparison with the least gifted child of the same age, do over six times as much in the same time or do the same amount with less than a sixth as many errors" (9) Thronike said.

Because of the lack of consideration of individual differences in the classroom teaching of mathematics, the number of failures in the subject is proportionally higher than other subjects. For mathematics is a sequence subject, the new method of teaching has given stress on individualistic teaching. But in the present system of education, the teacher dominated teaching, note learning by pupils, and information based examination system continue to dominate the scene despite the effort to bring about reforms in education.

"In order to make education meaningful exciting activity for the pupil and the teacher, there is need to bring the relationship between objectives, contents and teaching methodologies into clearer relief. The teacher should be made to realise the important fact that the objectives of education can be achieved only through appropriate teaching strategies, keeping in view the content which has to be taught" (10)

It is worth noting that the selection of methods of teaching mathematics in the classroom depends on the topic to be taught. In school mathematics, each topic has four objectives to be stressed and the approach of teaching can not be same for all topics. To develop knowledge among pupils about a topic, the technique of direct exposition and self learning devices may be more useful. In order to develop the abilities of analysis, synthesis and evaluation which form

(9) Aiyangar, N. Kuppuswamy - The teaching of mathematics in New Education - Prakashan Kendra, Delhi - P-216.
(10) Singh, Bhoodev - Teaching learning strategies and mathematical Grativity Mittal Publication Delhi, P-1-5
1.5 Methods of instruction adopted in the present study:

Teaching as it is said is an art, methods are the way to understand and practise the art. Different methods of teaching mathematics have been proposed or propounded by different educational thinkers or school of thoughts in education. There are some most modern methods for teaching mathematics at the secondary level. Out of which the following three methods are considered in the present study.

Those are: (a) Programmed Instruction method (b) Integrated Programmed Instruction method and (c) Objective Based Teaching method. All those methods are considered on the view that the population explosion in India, has resulted in more number of students in schools and colleges. As a result, there is very large number of students population in our educational institutions. We have more children than even before inside the schools. This problem is now acquiring another dimension. We have to teach more and more. More teaching demands efficient teaching, better methods, new techniques and better utilisation of available equipments. All these require more resources. But the existing resources are not sufficient to provide all the requirements. When the class strength becomes large, the individuals in the class will be more varied and as a result, the individual difference will be more pronounced. Since learning is highly individualistic, ideal teaching should, therefore be individualistic so the above methods have been considered for this study.

DETAILS OF METHODS:

(a) Programmed Instruction Method:

Programmed Instruction (or programmed learning) was developed by Kenneth E. Brown and Theodere L. Bell (1966). A programme of instructions describes more or less in general terms what is to be achieved by students (who are homogenous at least in respect of ages), instructional materials and instructional arrangements. All teachers
important counterpart of mathematical creativity and problem solving among pupils, inquiry and discovery approaches are more useful. Mathematics teaching requires more emphasis on the process aspect rather than product. So problem solving, inductive reasoning, creativity teaching devices are to be selected to teach mathematics.

1.4 Present day situation of teaching-learning of mathematics:

The standard of mathematics in the school level in average, is deteriorated in the present day and it causes a serious problem which disturbs all those who are concerned with teaching. The general attitude of the pupil for this subject is found to decline as the pupil goes up in the ladder of education when a child learns the simple process of addition like $3 + 3 = 6$, he feels happy and tries to repeat the same in different situations but unfortunately as he grows, his joy of learning is lost and an aversion for mathematics is developed. The reason is that the subject is taught mechanically without any life in its approach. P.L. Bhatnagar has rightly said:

"If mathematics is a way of thinking, then it is clear that the subject has to be presented in such a manner that it excites the thinking processes and creates excitement during thinking till the joy of achievement is attained." (11)

The reason is that the teacher gives emphasis on rote learning rather than understanding. The instructional outcome i.e. what the students achieve at the end of the instruction is not attained. In other words, the change of behaviour of students that the teacher wants to achieve at the end of the instruction is not observed. According to Bruner.

"Any subject can be taught effectively in some intellectual honest from to any child at any stage of development". (12)

(12) Sidhu, K.S. - The teaching of mathematics, stirling Publisher Private Limited 1990.
are to plan or to programme their instructions with an average student in mind for teaching a group of students on the assumption that all students learn at the same speed. This assumption is wrong in reality where only average students does not exist in the classroom. However the instructions are meant for average pupils.

In the programmed learning approach, the information is presented in a planned sequence. The content is divided into small pieces of informations and each piece of information is given in a frame. Students are to read the frame and answer the question or questions in the frame and to write down the answer on a piece of paper. Then the answer are to be compared with the answers given below each frame at the right corner. Those answers are not to be seen before. The answers are ready by the pupils. If the answers given by the pupil are correct, the pupil can read the next frame, but if the answers obtained by pupils are wrong, the pupil has to read that frame again and tries to find the correct answer. In this way, all frames are to be completed by reading and answering. This is the procedure of study the programmed frames. Some of the important features of this programmed instruction are : (1) analysis of the instructional task (2) Specification of instructional outcomes in behavioural terms. (3) Planned sequence of the instructional events. (4) Continuous explicit response from the learner. (5) information about the appropriateness of the learner response (6) individualised learning at the learners speed (7) self sufficiency of the programme.

(b) Integrated Programmed Instruction Method:

In this method, more informations are clubbed together to form a frame. Such frame must be a planned sequence of the instructional events. The instructional outcomes from such frame must be expressed in behavioural terms. Other characteristics are same as in programmed instruction method.
(c) **Objective Based Training Method**:

In this method, the content of the topic or lesson is analysed in a systematic manner keeping in mind the behavioural aspect of the cognitive domain of the human mind. In general, for the development of the cognitive domain, the four objectives: knowledge (Kn), understanding (Un), Application (AP), and skill (S) are considered at the secondary level of school education. The teaching points of each topic to be taught are selected in a systematic and graded manner and each point is argued under the head: what of a point? why of a point? How of a point? and its evaluation. "What" of a point means the content matter of that point, 'Why' means learning outcome. How of the point means 'learning experience' and evaluation means the testing of student regarding the point of content that has been taught. Thus a lesson plan is prepared for each topic or lesson before starting the topic. In this way lesson plan of all topics in a subject are made. Since mathematics is a process subject, this method of teaching has a significance. As the reform of school mathematics is based on conceptual understanding of the topic, the objective Based Teaching method has its importance and effect in learning. So this method is selected as one of the methods teaching mathematics at the secondary level.

The present study is designed to measure the effectiveness of these three methods to teach mathematics at the secondary level of Arunachal Pradesh in the North East region.