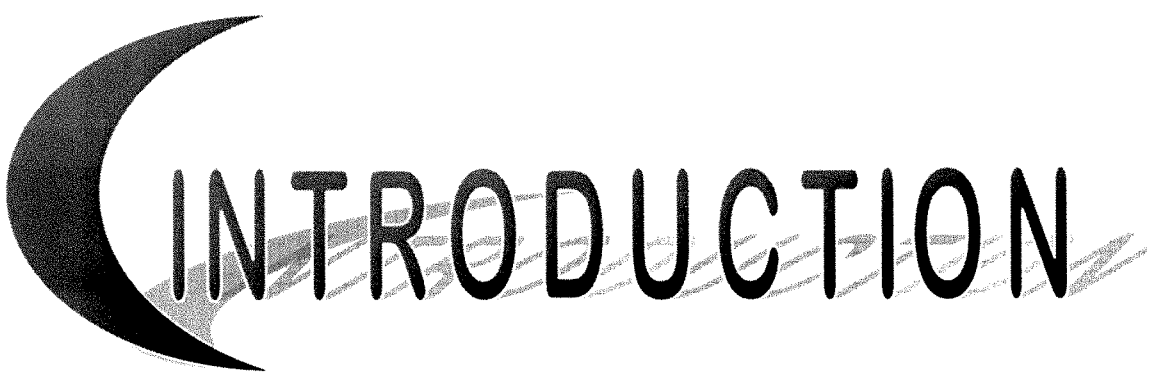
Chapter 1



INTRODUCTION

Mathematics is a living and flourishing subject. It is a discipline in its own and a service subject used in all facets of life. It is a universal means of communication. The impulse for the advancement of mathematical knowledge, which is both, most fundamental and most far reaching in its practical and ideal effects, grows out of the pursuit of knowledge, pursuit of truth. The way in which mathematics has interacted usefully with other subjects in the progress of thought justifies the method of abstraction as profitable. It seeks the highest standards of understanding by demanding rigor in its foundation and development.

As a subject mathematics has a great value – aesthetic, utilitarian, and social. It plays indispensable role in shaping our mind and behaviour. Mathematics is not just a tool to assist science; rather it is an approach to develop scientific tempers, which leads to the highest level of the human enquiry. Mathematics sets the path of self-actualization as mathematical discovery are nothing but union of phenomenon with human behaviour.

1.1.1 PLACE OF MATHEMATICS IN SCHOOL CIRCULUM

Up to the present moment, we have not come across any curriculum framework at the national and international level, which does not figure mathematics as one of the core components. Perhaps the only subject occupying unrivalled position.

One can attribute a number of reasons for this position of the subject mathematics, but the major reason is that mathematics has been civilized for many centuries as, the subject par excellence in which reasoning powers could be trained. It is a subject that develops and trains an individual's fundamental mind. Another major reason is its use in other disciplines and is seen as a subject

that serves to develop basic academic competencies. Mathematics has played fundamental role in the economic development of the society. The great achievements of technology in all forms, which influence life of every human being is made up possible because of the subject mathematics. The importance of course with mathematical basis is providing job opportunities have further strengthened its position in schools. In last centuries or so, mathematics has been used as a screening device for entry to numerous professions. In future also the fastest growing occupations will require employees who have much higher mathematical capabilities.

All these points to the fact that mathematics has achieved central place in school curriculum and will continue to have this privilege position in future all over the world. However, in secondary level, the students' understanding about the basic concepts of mathematics doesn't meet the expected level. (Sasidharan, 1992; Pushpanadham, 1996 & Rachana, 2009). This is a deplorable and appalling situation in the field of mathematics education. Pedagogical, intellectual, emotional and social factors are the root cause for this scenario (Edward, Hinderson & Thomas, 1998).

1.1.2 PORTRAIT OF MATHEMATICS CLASSROOM

Research studies conducted in mathematics education have revealed that the mathematics class rooms are dull, bored and the majority of the students find it as a difficult subject. This scenario is only due to inappropriate methods of teaching mathematics and the lack of basic concepts. (Chitkara, 1985; Pushpanadham, 1996; Saju, 2005 & Rachana 2009). Since students learn at different rates, the instructions in mixed ability classroom are too easy for some and difficult for others. (Hunter, 1977; D'Ambrosio, 2001; Saju, 2005). At any given time, students reflect differing levels of academic readiness in various aspects of mathematics subject.

Acknowledging that students learn at different speed and they differ widely in their ability to think abstractly or understand is like acknowledging that students at any given age are not all the same height. It is not a statement of worth, but of reality (Tomlinson, 1998).

Teacher's observation of the student behavior indicates that while teachers teach to the middle ability level, they are not challenging the higher ability student or not addressing the lower ability student needs. Therefore, both groups demonstrate frustration, in attentiveness and lack of interest in mathematics. Students in mixed ability class rooms have many different learning styles and also have different emotional and social maturity level. Teachers generally gear their teaching to the mythical average student on the assumption that this level of presentation will meet the needs of the most number of students (Ornstein, 1995). Lower and higher level of students become frustrated because the pace of the scope and sequence in the math curriculum does not challenge the higher level students or accommodate the needs of the lower level students.

Another aspect is regarding motivation. According to Hunter and Breit (1976) to increase motivation there must be a certain amount of anxiety present. In order for a child to learn, there must be some anxiety. If there is too much anxiety, students will use their energy to combat the anxiety. If there is no anxiety, students will be unmotivated. This also demonstrates the types of problems that will occur when presenting material to one ability level. Therefore, in a mixed ability classroom, these types of problems will be apparent. Lower, middle and higher level ability students may demonstrate in attentiveness, frustration and a lack of motivation when teachers teach to a specific academic ability or teach the same material to everyone.

By critically analyzing the present mathematics classroom, it is observed that:

- Not all students need to be doing the same thing at the same time.
- Students are not all at the same level of ability and they don't learn in the same way.
- Students need to be actively involved in making decisions and modifications to their learning efforts.
- Students need appropriate challenges, a secure environment, and an opportunity to explore ideas and have fun learning.
- Students need to learn to ask questions, think and interact verbally.
- Students need to be able to construct meaning by interacting with peers, and working on problems, issues and materials.
- Learning is more effective if concepts are learned in context and related to existing knowledge. Content needs to be relevant, integrating multiple aspects simultaneously.
- Peer teaching may not be as valuable for the child who is teaching as for the learner.

All these problems point out that, differently able students posses different learning styles. The students are unique in their personalities, cultural experiences and values. Different students prefer different learning environments, learning modalities and they all exhibit unique strengths or weaknesses (Chitkara, 1985). To become a successful teacher, they should provide a variety of learning approaches so that the learning differences can be recognized and provided in every classroom. Understanding the

different ways that students learn, interact and process information can help teachers to modify the way they teach so that all students have an equal opportunity to succeed.

There is little doubt that students can modify their learning style as they mature and gain experience in a range of learning methods. Although classroom modifications made to take advantage of student learning strengths are very valuable, it is also necessary for students to develop alternative learning strategies and thinking skills to prepare them for the tasks that require specific modalities. The auditory learner will periodically face problems that require a hands-on solution. Also, the visual learner will encounter problems and situations that demand the use of kinaesthetic and/or auditory skills. Consequently, there is a need to find a balance between building on students' natural strengths and developing an adequate range of alternative learning strategies. So it is clear that, it is improper to prescribe instructional methods or categorize groups of learners by presuming that they have similar style preferences.

1.2 CONCEPTUAL FRAMEWORK OF THE STUDY

The students mind is a growing organism. It is not a box to be ruthlessly packed with alien ideas; and instead they should provide natural food for developing intelligence. To make the food of education palatable to the child under suitable condition and to prevent them from taking wrong food, suitable method must be followed in educating the child. It will definitely help in the development of child. Methods are the means through which the goals of education can be realised. Mathematics is a subject, which needs to be taught in homogeneously grouped classes (Boaler, Dylan & Brown).

1.2.1 LEARNING

Learning occupies a very important place in our life. Most of what we do or do not do is influenced by what we learned and how we learned it. Learning, therefore, provides a key to the structure of our personality and behavior. An individual starts learning in a strict sense even in the womb of the mother. Experience, direct or indirect is found to play a dominant role in moulding and shaping the behavior of the individual from the beginning. The thinkers and psychologists were given different definitions for learning. It may be recapitulated as learning is a process which brings relatively permanent changes in the behavior of a learner through experience or practice.

1.2.2 DIFFERENT SCHOOLS OF PSYCHOLOGY ON LEARNING

Different psychologists at different times have expressed their views to explain the why and how of human behavior. This has led to establishment of different schools of thought or systems of psychology affecting the products and process of education.

1.2.2.1 Structuralism

Structuralism emphasized the systematic study of the mind through the study of its structure by adopting introspection as the main technique. It focuses on conscious experience involving one's thoughts, feelings, sensations, perceptions and ideas. According to structuralism, consciousness experience because of physical sensations, feelings and images.

1.2.2.2 Functionalism

Functionalism considered the minds function is to aid man's adjustment to his environment. The minds are constantly forging associations, revising experiences, starting, stopping, jumping back and forth in time for adding to our functional abilities to adapt to

our environment. It laid emphasis on functionality of the contents of the curriculum by advocating that only those things should be taught to the children which they could apply in everyday life.

1.2.2.3 Behaviorism

As a school of thought behaviorism focuses its attention totally on the overt or observable behavior for its objective observation and considers environmental forces to be the sole factor in shaping one's personality and influencing one's behavior. It revolutionized the field of education by strongly emphasizing the need of proper environmental organization for better growth and development of the child. According to them behavior is merely the response to some environmental stimulus.

1.2.2.4 Gestalt Psychology

Gestalt psychology emphasizes the role of configuration or organization in the perceptual field and highlights the role of insight and understanding in learning or problem solving. According to it, an individual perceives the thing as a whole and not as a mere collection of its constituents or elements. Thus this school of thought paved the way for organizing the subject matter and curricula as a whole in relation to various learning areas and experiences, proceeding from the whole to part etc. It has emphasized the need for making the task of learning or problem solving an intelligent task, based on insight and understanding rather than unintelligent repetition and mechanical reproduction.

1.2.2.5 Humanist Psychology

Humanist psychology gives more value to the human being by not considering him merely as a sophisticated machine or a victim of the conflict between the ego and the id. It considers him as a purposeful being, capable of adapting himself to his environment

and choosing his own course of action in order to achieve the goals which he has selected for himself. These goals may be as simple as the satisfaction of a common physical need or as lofty as the attainment of self-realization or personal fulfillment.

1.2.2.6 Transpersonal Psychology

Transpersonal Psychology focuses its attention on the study of personal experiences that seem to transcend ordinary existence. In other words, what we think and how we feel in our altered states of awareness is the subject area of transpersonal psychology. These states may be reached during states of severe stress and distress or in moments of great excitement and happiness. They may be aroused during the period of sleep or deep concentration.

1.2.2.7 Cognitive Psychology

This new school of contemporary psychology is the result of the wave of intellectualism demonstrating faith in man's higher cognitive abilities and capacity to adapt to his environment and struggle for perfection. Cognitive psychology studies man's thinking, memory, language, development, perception, imagery and other mental process in order to peep into the higher human mental functions like insight, creativity and problem solving. Cognitive psychologists are totally opposed to the stimulus-response approach of the behaviorists. The human mind does not accept information from its environment in exactly the form and style it is conveyed to him. The conveyed information is compared with the information already stored in the mind; it is then analyzed and often enlarged upon and given a quite new form. Finally, it is subjected to interpretation and then used or stored according to the need of the time.

1.2.2.8 Social Psychology

Observation of other's behavior may play a leading role in learning and acquiring various things concerning one's environment. The cognitive psychologists who appreciate the role of observation in learning are termed as social psychologists and the theory of learning they propagate is known as the social learning theory. Observational or vicarious learning rather than learning based on direct experiences is the base of the social learning theory. The advocates of this theory emphasize that most of what we learn is acquired through simply watching and listening to other people. Direct experiences no doubt constitute the most effective and powerful sources of one's learning but the role of indirect experiences leading to observational learning can also not be underestimated. In many cases, they prove more desirable, less expensive and more beneficial than the direct experiences.

1.2.3 LEARNING STYLES

Individuals learn and process information in different ways. Most teachers deliver instruction in one way. We have heard that one learner is smarter than the other. Really this learner just is different. Training programs must take into account that learners are all different and organize learning process in a way that all learners benefit.

There are many ways to classify learning styles. Most classifications are based on perceptual modalities – the primary way our bodies take in information. According to the widely-used learning styles by Fleming VAK/VARK model, learners are classified into three classes:

- Visual,
- Auditory,
- Kinesthetic or Tactile.

Visual learning is a teaching and learning style in which ideas, concepts, data and other information are associated with images and techniques. Visual learners prefer to have information presented in graphs, graphic organizers such as webs, concept maps and idea maps, plots, and illustrations such as stack plots and Venn plots, are some of the techniques used in visual learning to enhance thinking and learning skills. Visual learners are said to possess great instinctive direction, can easily visualize objects, and are excellent organizers.

Auditory learning is a learning style in which a person learns through listening. An auditory learner depends on hearing and speaking as a main way of learning. Auditory learners must be able to hear what is being said in order to understand and may have difficulty with instructions that are written. They also use their listening and repeating skills to sort through the information that is sent to them.

Kinesthetic learning is a learning style in which learning takes by the student actually carrying out a physical activity, rather than listening to a lecture or merely watching a demonstration. It is also referred to as tactile learning. According to proponents of the learning styles theory, students who have a predominantly kinesthetic learning style are thought to be natural discovery learners: they have realizations through doing, as opposed to having thought first before initiating action. They may struggle to learn by reading or listening.

Apart from this, the great trios in educational psychology, Piaget, Ausubel and Bruner had given new faces for learning.

The work of Jean Piaget (1936), a Swiss Psychologist's, has had some of the most significant impact on learning. His work on

two aspects of how ideas were formed spanned a considerable part of the 20th century. Piaget's early and late periods were dominated by the active construction of meaning, where he proposed that, through the twin process of accommodation and assimilation, schema were constructed. His middle period was dominated by stage theories, where he tried to develop a theory of how young students went through particular stages in their patterns. Piaget's writings on children's cognitive and affective development were extremely influential in education, particularly from the 1950s onward. In more recent years, the influence of this theory has declined because of the view that it tends to highlight what children cannot do, rather than what they can do.

David Paul Ausubel (1960) was an American psychologist and the most significant contribution to the fields of educational psychology, cognitive science, and science education learning, was on the development and research on advance organizers. Ausubel was influenced by the teachings of Jean Piaget. Similar to Piaget's ideas of conceptual schemes, Ausubel related this to his explanation of how people acquire knowledge. David Ausubel theorized that people acquire[d] knowledge primarily by being exposed directly to it rather than through discovery. In other words, Ausubel believed that understanding concepts, principles, and ideas are achieved through deductive reasoning. Similarly, he believed in the idea of meaningful learning as opposed to rote memorization. In the preface to his book Educational Psychology: A Cognitive View, he says that "If he had to reduce all of educational psychology to just one principle, he would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (Ausubel, 1968). Through his belief of meaningful learning, Ausubel developed his theory of advance organizers. Advance organizers provide

scaffolding, or support for new information. This is achieved by directing attention to what is important in the coming material, highlighting relationships, and providing a reminder about relevant prior knowledge. Advance organizers are helpful in the way that they help the process of learning when difficult and complex materials are introduced.

Jerome Seymour Bruner (1966), an American psychologist also contributed to cognitive psychology and cognitive learning theory in educational psychology, as well as to history and to the general philosophy of education. Bruner's ideas are based on categorization: "To perceive is to categorize, to conceptualize is to categorize, to learn is to form categories, to make decisions is to categorize." Bruner maintains people interpret the world in terms of its similarities and differences. He has also suggested that there are two primary modes of thought: the narrative mode and the paradigmatic mode. In narrative thinking, the mind engages in sequential, action-oriented, detail-driven thought. In paradigmatic thinking, the mind transcends particularities to achieve systematic, categorical cognition. In the former case, thinking takes the form of stories and "gripping drama." In the latter, thinking is structured as propositions linked by logical operators. In his research on the development of children (1966), Bruner proposed three modes of representation: enactive representation (action-based), iconic representation (image-based), and symbolic representation (language-based). Rather than neatly delineated stages, the modes of representation are integrated and only loosely sequential as they "translate" into each other. Symbolic representation remains the ultimate mode, for it "is clearly the most mysterious of the three." Bruner's theory suggests it is efficacious when faced with new material to follow a progression from enactive to iconic to symbolic representation; this holds true even for adult learners.

1.2.4 WHAT IS MATHEMATICS?

When a member of general community is posed this question, they invariably focus on number and operations. How ever modern mathematics is far more complex than just arithmetic. School mathematics has changed over time. During different periods different mathematics was taught. New topics were included, new forms of thinking mathematically (e.g. set theory) were part of the new syllabuses. Students are expected to be far more creative in their thinking, and to deal with much more knowledge and complexity than in the pre-1960s era.

1.2.4.1 Mathematics is the Study of Patterns and Relationship

One of the defining characteristics of mathematics is being aware of recurring ideas and relationships between and among mathematical ideas. The knowledge learnt in one area of mathematics links to other areas. Looking for patterns and relationship is very much a part of mathematics. Through patters we make conjectures and generalization.

1.2.4.2 Mathematics is a Way of Thinking, Seeing and Organizing the World

Students who come to learn mathematics as a dynamic discipline through which much of the world can be interpreted are able to make sense of a wide range of experiences. They are able to organize and analyze events in systematic ways. Sometimes this might be numerically but it could equally be spatially or through logic. By viewing the world through a mathematical lens, considerable progress can be made in everyday circumstances, such as remembering phone numbers, because a pattern can be seen and people are thus able to solve problems more efficiently and effectively. Mathematics moves beyond memorizing a vast body of

facts and procedures in a rote manner to a more systematic and insightful process.

1.2.4.3 Mathematics is a Language

In past times, mathematics and language were seen as two disparate disciplines. Today it is seen that in order to learn, appreciate and understand mathematics, students need to learn the language of mathematics – complete with its unique grammar and symbols. By knowing the language of mathematics, complex ideas can be easily communicated. Language involves communication and mathematics is a very particular and precise language that is communicated in particular ways. It involves the contraction of lengthy tasks into short and concise 'sentences'.

1.2.4.4 Mathematics Is a Tool

People use mathematics to solve problems every day. The more competent person is with mathematics, the more efficiently problems can be solved, and in many cases, the better one can survive in the world beyond the schools. Deciding which goods to purchase, checking bank balances, being able to budget or deciding which mortgage to take out, can all be done through the use of mathematics. Mathematics enables people to make sound decisions and judgements and to solve problems.

1.2.4.5 Mathematics is a Form of Art

For most students mathematics is a grind that has to be done under duress. In contrast in contrast, for those who have been fortunate enough to engage with mathematics, its internal beauty is awesome to behold – it has the consistency of a fine artwork. The logical coherence of Fibonacci's numbers, for example, is almost magical. This aspect of mathematics is perhaps the most elusive for many people since they equate mathematics with the school

process of 'doing mathematics' rather than something to be appreciated.

1.2.4.6 Mathematics Is Power

Mathematics has been behind most inventions – good and bad – in modern history. It has enabled us to walk on the moon, but also to invent the atomic bomb and mass destruction. Those students who succeed in mathematics are more likely to live than those who don't. Mathematics is the social filter that facilitates the access of some students to professions of high status, wealth and power while excluding others. Developing nations actively seek their young to have access to mathematics, for they know that such knowledge will benefit them in future. Many western countries are recognizing the problems inherent in increasingly fewer students under taking formal studies in mathematics, for its foundation for many other forms of powerful knowledge. Computing, science, technology, research, all has a heavy reliance on mathematics.

1.2.5 THEORETICAL FOUNDATIONS FOR CONTEMPORARY MATHEMATICS EDUCATION

To be able to plan how to teach mathematics effectively, there needs to be some understanding of how students learn mathematics. The role of theory in underpinning practice is an essential element of quality teaching in mathematics. By having an idea of how students learn, teachers are better able to plan for and anticipate in particular ways, and to create learning environments to facilitate better learning. Three significant classes of theories have influenced our understanding of how students come to learn and understand mathematics:

- Cognitive theories that focus on students thinking;
- Socio-cultural theories that seek to understand cognition within a social context; and
- Social (or socially critical) theories.

1.2.5.1 Cognitive Theories

1.2.5.1.1 The influence of Piaget

The work of Jean Piaget (1972) has had some of the most significant impact on mathematics education. His work on two aspects of how ideas were formed spanned a considerable part of the 20th century. Piaget's early and late periods were dominated by the active construction of meaning, where he proposed that, through the twin process of accommodation and assimilation, schema were constructed. These ideas are foundational to the significant impact of constructivism in mathematics education. His middle period was dominated by stage theories, where he tried to develop a theory of how young students went through particular stages in their patterns. Piaget's writings on children's cognitive and affective development were extremely influential in education, particularly from the 1950s onward. In more recent years, the influence of this theory has declined because of the view that it tends to highlight what children cannot do, rather than what they can do.

One important focus of Paget's work is the development of logico-mathematical knowledge. In particular, he made a major contribution to the understanding of the development of number concepts in young children as well as the development of concepts relating to logic, time, space and geometry, and movement and speed. Since the early 1980s Piaget's theories have constituted one of the main bases for the development of constructivist theories in education.

1.2.5.1.2 Constructivism

'Constructivism' is a term that has been used in education and educational psychology with increasing frequency since the late1970s. Today, any serious discussion of learning theory related to mathematics, science or literacy, for example, would include a detailed discussion of constructivism. As outlined by Cobb (2000):

> 'A range of psychological theories about learning and understanding falls under the heading of constructivism. The common element that ties together this family of theories is the assumption that people actively build or construct their knowledge of the world and of each other'.

The impact of Piaget's work in contemporary mathematics is obvious in the ways in which constructivism, and its numerous versions, has been taken up by teachers and curriculum writers. There are number of different forms of constructivism, but underpinning all versions are three premises:

- Rather than being passively received, knowledge is actively constructed by students.
- Mathematical knowledge is created by students as they reflect on their physical and mental actions. By observing relationships, identifying patterns and making abstractions and generalizations, students come to integrate new knowledge into their existing mathematical schemas.
- Learning mathematics is a social process where, through dialogue and interaction, students come to construct more refined mathematical knowledge. Through engaging in the physical and social aspects of mathematics, students cone to construct more robust understandings of mathematical concepts and process through process of negotiation, explanation and justification.

Constructivism recognizes that mathematics must make sense to students if they are to retain and learn mathematics. For students to develop appropriate knowledge they must be provide with rich learning experiences so that their constructed meanings and understandings are in keeping with the discipline of mathematics.

1.2.5.1.3 The Importance of Dialogue and Argumentation

Within the constructivist paradigm, the role of language and dialogue is central to fostering learning environments. Providing appropriately organized experiences where students can talk with their peers allows them to explore ideas in language and concepts that is similar to their own. This enables higher achieving students to practice their control of language and lower achieving students to hear ideas being modeled in a language that is more likely to be in a genre that they can access. Having students explain their ideas to their peers often supports both sets of learners.

1.2.5.1.4 Constructivism in the Mathematics Classroom

Within a constructivist classroom, the teacher acknowledges that students will have constructed a range of understanding from any given interaction on the basis that they have entered the context from a range of different perspectives and experiences. A constructivist perspective recognizes that it is not possible to assume that the teaching of a concept relates to the development of the ideas proposed by the teacher and that, indeed, there will be a multiplicity of understandings constructed by the range of students in the classroom. A constructivist teacher realizes that having taught something does not mean that students have learnt exactly what was envisaged by the teacher. It is important for the teacher to use a range of tools and techniques to assess what the students have constructed. By identifying what the students have

constructed, the teacher is then able to identify constructions that are akin to what has been the objective of the lesson along with being able to identify misconceptions. It is the misconceptions that allow the teacher to access what the students have come to construct and thus develop teaching strategies that will move the students into more appropriate constructions.

1.2.5.2 Socio-cultural Theories

Lev Vygotsky is regarded as the founder of socio-cultural theory (Cole, 1996; Moll, 1990). Vygotsky's work, which is embodied in the literature on socio-cultural theories of learning mathematics, has gained increasing importance in theorizing hoe students learn mathematics. Vygotsky saw that students internalized complex ideas (Daniels, 1990), but extended the general constructivist approach by arguing that the internalization of knowledge could be better achieved when students were guided by good, analytic questions posed by the teacher.

The expert teacher is central to Vygotskian theory. The teacher's role is to identify the student's current mode of representation and then, through the use of good discourse, questioning or learning situations, provoke the student to move forward in her/his thinking. The recognition of a student's representation or thinking was seen as her/his zone of proximal development and the teacher's actions for supporting learning was described as scaffolding. When working in the 'zone of proximal development' particular attention is to paid to the language being used since the language of the student influences hoe she/he will interpret and build understandings (Bell and Woo, 1998). Within a Vygotskian approach it is seen to be important that teachers use and build considerable language and communication opportunities within the classroom environment in order to build mathematical understandings.

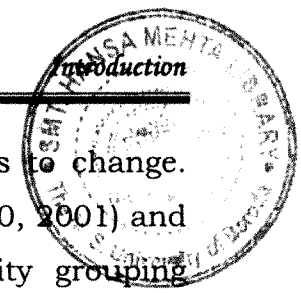
1.2.5.2.1 Scaffolding

Good teaching involves teachers knowing their students' current thinking about mathematical concepts and then knowing how to move the students towards more complex, complete and robust constructions through the use of organized learning activities and environments. Good questions are important in facilitating learning. Typically, good questions are those that foster deeper levels of learning as opposed to recall.

1.2.5.3 Socially Critical Theories

Sociological theories, particularly critical sociology, have gained increasing importance in mathematics. These theories shift the focus of learning mathematics away from the individual to a more macro level of analysis. In part, this interest has stemmed from the consistent poor performance of students who come from particular back grounds. It is now recognized internationally that particular students are more at risk of not performing well. Aside from students with learning disabilities, these are indigenous students of almost all nations; students from working class (or low socioeconomic status) families; students who live in remote or rural areas. When gender is considered in concert with these variables, differences are exacerbated (Walkerdine, 1988, 1989). It has long been recognized that girls have been particularly disadvantaged in the study of mathematics due to gendered practices in teaching and assessment (Fennama and Meyer, 1989; Leder, 1992). However, it is now recognized that this applies not to girls per se, but to girls from particular social and cultural backgrounds. Rather than assume that success is due to some innate 'mathematical ability', socially critical theories have the practices of school mathematics as the focus of attention.

Socially critical theories explore the practices of mathematics education to see how they are implicated in the reproduction of



inequalities and in so doing, challenge such practices to change. Assessment, mathematical language (Zevenbergen, 2000, 2001) and classroom talk, textbooks (Dowling, 1998) and ability grouping (Boaler, 1997) are some of the areas that have been critically examined in terms of the ways in which social, cultural, linguistic and gender differences are reproduced through mathematics education. These studies have illustrated the very subtle ways in which school mathematics contributed to, and legitimates, the failure of particular group of students.

Mathematics is one of the most important subjects in the school curriculum and it serves a particular role as a social filter. The work of Lamb (1997) showed that success in school mathematics is the best predictor for future success in life. Thus it is important for all students to succeed in school mathematics – regardless of background, gender or language. By knowing how practices are implicated in the construction of differences, teachers can change their practice in order to produce more equitable classrooms and outcomes.

1.2.5.4 Theory into Practice

The value of a good theory is its capacity to enable teachers to develop good practice that supports and enhances student learning. Teachers need to have a strong theoretical basis to their work. By understanding hoe students learn, teachers are able to organize the learning in ways that will enhance the capacity for learning. When trying to understand why some students have more difficulty in passing mathematics than others, socially critical theories are useful for examining the practices of mathematics.

1.2.6 DIVERSITY AND EQUITY

Students enter mathematics classrooms with a wide range of background knowledge, experiences and dispositions. These

differences which arise both before they come to school and while they are in school create different orientations and learning experiences. For some students their experiences will help them in their learning of mathematics, for others considerable input will be needed to support their learning.

When considering how one deals with diverse class rooms, two different positions exist. Some teachers advocate an approach whereby each child is treated the same, as they see this as fair. Others advocate an appropriate which recognizes that differences are evident and thus, in an attempt to redress these differences, that students need to be treated differently.

1.2.6.1 Equality View

Assumption I: It is important that all students are fair chance at succeeding so all students should be given the same opportunities. It is up to the student to choose which options they want. If they want to succeed, the opportunities are provided for them.

Assumption II: Discourse of equality subscribe to principles of fairness and choice.

1.2.6.2 Equity View

Assumption I: Disadvantaged students are more likely to perform poorly at school due to different home circumstances and the practices of school mathematics not aligning with the knowledge, skills and dispositions the students bring to school.

Assumption II: If disadvantaged students are to succeed in mathematics, different opportunities need to be made available to them in order to redress the differences in school and non-school experiences.

Assumption III: Discourse of equity subscribe to principles of justice and difference.

In considering these two very different views, it becomes clear that if students enter school with very different learning experiences - some which are recognized in school and others which are not - their chances of success are different. This raises the question as to what teachers then do with these diverse students.

1.2.7 DIFFERENTIATED INSTRUCTION

Differentiating instruction means creating multiple paths so that students of different abilities, interest or learning needs experience equally appropriate ways to absorb, use, develop and present concepts as a part of the daily learning process. It allows students to take greater responsibility and ownership for their own learning. *Brain Research* identified the assumptions underlying the differentiated instruction are:

- No two children are alike.
- No two children learn in the identical way.
- An enriched environment for one student is not necessarily enriched for another.
- In the classroom one should teach children to think for themselves.

Differentiating is not new; the concept has been around for at least two decades for gifted and talented students. However, it is now recognized to be an important tool for engaging students and addressing the individual needs of all students. There are generally several students in any classroom who are working below or above grade level and these levels of readiness will vary between different subjects in school. It is important to offer students learning tasks that are appropriate to their learning needs rather than just to the grade and subject being taught. This means providing three or four different options for students in any given class. Readiness,

learning styles and interest vary between students and even within an individual over time. In a differentiated classroom all students have equally engaging learning tasks.

Differentiation may begin by varying the content, processes or product for each group in the class. By content, we mean the material that is being presented. Process activities help students practice or make sense out of the content, while product refers to the outcome of the lesson or unit, such as test, project, or paper. As the teacher becomes more proficient using these techniques, differentiation can occur at all three stages of the process for some students. This is especially appropriate for the more able students. The essential curricula concepts may be the same for all students but the complexity of the content, learning activities and/or products will vary so that all students are challenged and no students are frustrated.

The following indicates the three different ability levels related to the content, process and product.

Content

Low Ability

- Student is expected to meet main objectives of the lesson.
- Students may need many modifications to understand the topic, have low ability or be lacking in the area of understanding mathematics

Average Ability

- Student is expected to master all of the objectives.
- Students are expected to perform at grade level.

High Ability

- Student is expected to go above and beyond the objectives for the lesson.

- Students are gifted, excel in specific areas and/or have a strong knowledge base.

Process

Low Ability

- Student needs direct instruction in each step of the process.
- Student needs review, practice and re-teaching.

Average Ability

- Student can learn from modelling.
- Student can do independent work
- Student needs review and practice.

High Ability

- Student learns with minimal instruction.
- Student conducts independent study.
- Student learns and grasps basic concepts quickly.

Product

Low Ability

- Student provides a group project for evaluation.

Average Ability

- Student is expected to complete a three-page, individual final project.

High Ability

- Student will create a class presentation with models, graphs and discussion points.

In Principles and Standards for School Mathematics, published by the National Council of Teachers of Mathematics of United States of America (NCTM, 2000) the writers asserted that, "All students, regardless of their personal characteristics,

backgrounds, or physical challenges, must have opportunities to study and support to learn mathematics. Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students." This statement suggests that effective instruction utilizes a continuum of methods to serve diverse student populations (Singelton, Tucker, & Weaver, 2002). Teachers can no longer rely on the notion that one size fits all and must instead create opportunities for students to learn in every situation. One of the biggest misconceptions about teaching and learning mathematics is the belief that there is only one method for determining solutions (Kelly, 2005). Those embracing this sentiment have left students with disabilities in a challenging position. Borg and Stranahan (2002) were on the stand that students will do better in a class when their learning styles are similar to the instructor's teaching style. So grouping children by ability is an inescapable practice.

1.2.8 ABILITY GROUPING

Ability grouping is the practice in education, of placing students into different groups within a school for instructions on the basis of their perceived capacities in learning. Ability grouping increases student achievement by reducing the disparity in student ability levels and this increases the likelihood that one can provide instruction that is neither too easy nor too hard for most students. Ability grouping allows the teacher to increase the pace and raise the level of instruction for high ability students, and to provide more individual attention, repetition, and review for low ability students.

Proponents of ability grouping say that it has several important strengths. Ability grouping allows teachers to give better direct lessons towards the specific ability level of the students in

each class. Another positive aspect of ability grouping is that since it separates students by ability, students work is only compared to that of similar ability peers. Also it allows for higher achievement of higher ability students (Kulik & Kulik, 1992). National Curriculum framework for School Education, 2000 and National Curriculum framework, 2005 recommends different strategies for different learners (high ability, average ability and low ability) but not on the basis of gender, class or caste. Grouping by ability - high ability students, average ability students and low ability students, have no threats to equity. The students are grouped according to ability because they possess unique characteristics.

1.2.9 HIGH ABILITY STUDENTS

A high ability student in mathematics is one who performs at or shows the potential for performing at an outstanding level of accomplishment in at least one domain when compared with other students of the same age, experience, or environment; and is characterized by exceptional gifts, talents, motivation, or interests. High ability students differ from their classmates in pace at which they learn, depth of their understanding and interest that they hold, which are especially important in mathematics.

High ability students in mathematics differ from the general group of students in the following abilities: understanding problems spontaneously, flexibility in handling data, mental agility of fluency of ideas, data organization ability, originality of interpretation, ability to transfer ideas, and ability to generalize (Greenes, 1981). Terman (1925), one of the first researchers to explore the psychological characteristics of high ability students, found that they were emotionally borderline neurotic or even psychotic individuals. Positive characteristics include being less conforming to peer opinions and more independent (Gottfried & Gottfried, 1996; & Joseph, 2006), exhibiting better emotional adjustment (Oram,

Dewey, & Rutemiller, 1995), valuing cooperative and democratic forms of interaction (Lehman & Erdwins, 1981), showing more leadership capabilities (Chitkara, 1985; & Roeper, 1992), and being generally better psychologically adjusted (Howard-Hamilton & Franks, 1995; Nail & Evans, 1997). On the other hand, some gifted students have been found to manifest overly elevated levels of sensitivity and emotional reactivity (Piechowski, 1991), to have more difficulties with same-aged peers who do not have high levels of cognitive ability (Davis & Rimm, 1994), and possibly to have lowered self-concepts (Lea-Wood & Clunies-Ross, 1995).

Since high ability students possess above characteristics they get bored with routine tasks but they resist changing away from interesting topics or activities. They are impatient with failure. According to Wine Brenner (1992), when teachers assume that the curriculum guides they have been given must be applied to all students, it creates a situation that most gifted students have a hard time dealing with. Many of these students will go through the motions, do the work and get an easy top grade. Other gifted students who are less motivated will turn in work that is sloppy and careless; because they fell they are wasting time. Still other gifted students will simply give up, reject anymore repetition and refuse to do something they know is not necessary. Also High level ability students generally complete their work earlier than average and lower students. Instead of them being given challenging or enrichment material, often times they are just given more of the same work to do. Sometimes gifted students are put into a group of themselves and left to figure out the work on their own. During this time teacher focuses more on the needs of the average and low ability students. When the teacher does not know what to do with gifted students, those gifted children become frustrated. All these point out that, to teach according to their learning style, high ability

students could be placed in a separate class and explore them to various experiences through which they construct knowledge.

Constructivism is a psychological theory of knowledge, which argues that humans generate knowledge and meaning from their experiences. Constructivist teaching approach is based on the constructivist learning theory. This theoretical framework relies on the earlier framework of cognitivism, which holds that learning should build upon knowledge that a student already knows; this prior knowledge is called a schema (Piaget, 1967). Constructivists suggest learning is more effective when a student is actively engaged in the construction of knowledge rather than passively receiving it. Constructivism is child-centered; it proposes that learning environments should support multiple perspectives or interpretations of reality, knowledge construction, context-rich, experience-based activities. Constructivism focuses on knowledge construction, not knowledge reproduction. It is a belief that one constructs knowledge from one's experiences, mental structures, and beliefs that are used to interpret objects and events. The mind is instrumental and essential in interpreting events, objects, and perspectives on the base that is personal and individualistic. Our view of the external world differs from others because of our unique set of experiences. Learning is internal process and influenced by the learner's personality, prior knowledge and learning goals. Constructivism describes a learner-centered environment where knowledge and the making of knowledge is interactive, inductive, and collaborative, where multiple perspectives are represented, and where questions are valued.

1.2.9.1 Constructivist Learning Intervention

The Learner as a Unique Individual: Social constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also seen as complex and

multidimensional. Social constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilizes and rewards it as an integral part of the learning process (Wertsch 1997).

The Importance of the Background and Culture of the Learner: Social constructivism encourages the learner to arrive at his or her version of the truth, influenced by his or her background or culture. Historical developments and symbol systems, such as language, logic, and mathematical systems, are inherited by the learner as a member of a particular culture and these are learned throughout the learner's life. This also stresses the importance of the nature of the learner's social interaction with knowledgeable members of the society. Without the social interaction with other more knowledgeable people, it is impossible to acquire social meaning of important symbol systems and learn how to utilize them. From the social constructivist viewpoint, it is thus important to take into account the background and culture of the learner throughout the learning process, as this background also helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process (Wertsch 1997).

The Responsibility for Learning: Furthermore, it is argued that the responsibility of learning should reside increasingly with the learner (Von Glasersfeld 1989). Social constructivism thus emphasizes the importance of the learner being actively involved in the learning process, unlike previous educational viewpoints where the responsibility rested with the instructor to teach and where the learner played a passive, receptive role. Von Glasersfeld (1989) emphasizes that learners construct their own understanding and that they do not simply mirror and reflect what they read. Learners look for meaning and will try to find regularity and order in the

events of the world even in the absence of full or complete information.

The Motivation for Learning: According to the social constructivist approach, instructors have to adapt to the role of facilitators and not teachers (Bauersfeld, 1995). Where a teacher gives a didactic lecture which covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. In the former scenario the learner plays a passive role and in the latter scenario the learner plays an active role in the learning process. The emphasis thus turns away from the instructor and the content, and towards the learner (Gamoran, Secada, & Marrett, 1998). This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher (Brownstein 2001). A teacher tells, a facilitator asks; a teacher lectures from the front, a facilitator supports from the back; a teacher gives answers according to a set curriculum, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions; a teacher mostly gives a monologue, a facilitator is in continuous dialogue with the learners (Rhodes and Bellamy, 1999).

1.2.9.2 The Nature of the Learning Process

Learning is an Active Social Process: Social constructivist scholar's view learning as an active process where learners should learn to discover principles, concepts and facts for themselves, hence the importance of encouraging guesswork and intuitive thinking in learners (Brown et al.1989; Ackerman 1996). In fact, for the social constructivist, reality is not something that we can discover because it does not pre-exist prior to our social invention of it. Kukla (2000) argues that reality is constructed by our own activities and that people, together as members of a society, invent the properties of the world.

Dynamic Interaction between Task, Instructor and Learner: A further characteristic of the role of the facilitator in the social constructivist viewpoint is that the instructor and the learners are equally involved in learning from each other as well (Holt and Willard-Holt 2000). This means that the learning experience is both subjective and objective and requires that the instructor's culture, values and background become an essential part of the interplay between learners and tasks in the shaping of meaning. Learners compare their version of the truth with that of the instructor and fellow learners in order to get to a new, socially tested version of truth (Kukla 2000). The task or problem is thus the interface between the instructor and the learner (McMahon 1997). This creates a dynamic interaction between task, instructor and learner. This entails that learners and instructors should develop an awareness of each other's viewpoints and then look to own beliefs, standards and values, thus being both subjective and objective at the same time (Savery 1994).

1.2.10 AVERAGE ABILITY STUDENTS

Average ability students, on most accounts, have been neglected by the researchers. There are very few studies which are related to average ability students. Average ability students are often late and miss class frequently. They put other priorities ahead of academic work. They may prepare their assignments consistently, but seldom in a perfect manner. They lack vision and bypass interconnectedness of concepts. They retain less information and for shorter periods. They are not visibly committed to class and participate without enthusiasm. They obtain mediocre or inconsistent results in test. Average ability students communicate in a way that often limit comprehension or risk misinterpretation (Franziz, et.al, 2008).

Research suggests that in mixed ability classrooms, students of average ability are capable of learning more and faster. But some other suggests that average ability students achieve at the same rate whether or not they are involved in ability grouping. Most of the educationists think in this way too. But Gentry & Owen (1999) found that average ability students have better achievement when they are grouped for a subject or two. Also there is a significant difference between high, average and low ability students in cognitive and non cognitive factors (Ayishabi, 1988; Joseph, 2006). Summarize that, average ability students also need to be taught by differentiated instruction.

Average ability students prefer visual learning style (John, Lauren and Michel, 1998). Average ability Students are expected to master all of the objectives. They can learn from modeling and can do independent work. Average ability students need review and practice. Integrated technology approach enhances the learning of average ability students. In its most recent document, the National Council of Teachers of Mathematics of United States of America (NCTM, 2000) stated, "Technology is essential in teaching and learning mathematics; it influences what is taught and enhances students' learning"

Integrated technology approach has enriched teaching of average ability students. This approach allows average ability students to explore whole new worlds in real time. Through this approach teachers can stimulate the minds of average ability students. They light the fire and capture the imagination. Integrated technology approach can offer average ability students a bridge from concrete to abstract thinking, enabling them to observe and create multiple representations of mathematical ideas: numerically, graphically, and symbolically. Integrated technology approach is now widely valued for its ability to enhance one of the most

significant intellectual developments for students: their emerging ability to think abstractly (Jarrett, 1998). Integrated technology approach has considerable potential for increasing interest in, and improving the quality of, learning in science and mathematics classrooms. Also integrated technology approach is terrific at remediation (Stewart & Kowaltzke, 1997).

1.2.11 LOW ABILITY STUDENTS

Low ability students when compared with normal students have been found inferior in intelligence and in physical development. They have lesser capacity of abstract thinking and to correlate various experiences. They have poor muscular coordination and slower reaction time. The social developments of low ability students lack behind the normal students of they reach. This is because of two reasons: first the perceptions of social situation is a matter of understanding and in the second place a student's backwardness has been apparent in the family and in the neighborhood long before he enters the school. They make good adjustment in the non-academic pursuits as a compensatory defense mechanism. They are good followers and highly appreciate what is done for them. They stick to their friends and develop successful adjustments (Haliyon, 2004). Because of these characteristics, low ability students have some problems in a normal classroom.

In the class room low ability students get frustrated when teachers direct the instruction to average ability students. Students develop mathematics anxiety which interferes with their ability to handle academic situations and everyday life that involve the manipulation of numbers. Tension and anxiety prevent low ability students from performing well in math which leads them to failure in mathematics Willaim (1988). Often times, lower level students have not had enough time to understand concepts and skills before

the teacher moves to next lesson. The assignment given to them is too difficult and falls too far ahead of their grade level. They lack motivation to learn, either because their background has been too deprived, their home-induced emotional problems are too severe or their learning attempts have received no suitable encouragement or inconsistent reinforcement by the teacher. They become failure oriented because of repeated defeats and thus no longer believe them capable of learning. Low ability students express frustration because they needed more time to understand what was being taught. We should remember that some people will never be able to run a mile in four minute or to play Beethoven Moonlight Sonata (Worthy & Hoffman, 1996). In fact, some research suggests that low ability students have increased achievement when high ability students are removed from the regular classroom (Gentry & Owen, 1999). Condense is that, grouping together and taught accordingly may be the one of the possibilities for low ability students for their betterment.

Scaffold instruction is "the systematic sequencing of prompted content, materials, tasks, and teacher and peer support to optimize learning" (Chard, Dickson, & Simmons, 1993). Using scaffold instruction optimizes low ability student learning by providing a supportive environment while facilitating student independence. Scaffolding is a process in which students are given support until they can apply new skills and strategies independently (Meister & Rosenshine, 1992).

Scaffolding allows the teacher to help students transition from assisted tasks to independent performances (Askew & Bliss, 1996; Bodrova & Leong, 1998; Palincsar, 1998). It is a step-by-step process that provides the learner with sufficient guidance until the process is learned, and then gradually removes the supports in order to transfer the responsibility for completing the task to the

student. The role of the scaffolding, however, is to eliminate the problems that could block students from getting it. The teacher must provide students with the optimal amount of support necessary to complete the task, and then progressively decrease the level of assistance until the student becomes capable of completing the activity independently (Elicker, 1995; Bodrova & Leong, 1998).

Scaffolding is temporary. Students acquiring knowledge should learn to become as self-regulated and independent as possible. When students are learning new or difficult tasks, they are given more assistance. As they begin to demonstrate task mastery, the assistance or support is decreased gradually in order to shift the responsibility for learning from the teacher to the students. Thus, as the students assume more responsibility for their learning, the teacher provides less support. The teacher must incorporate the interests of her students, to develop an understanding of the task until there is a moment of "I get it", and in turn continue to maintain their interest. This allows risking taking the next step. Teachers must select activities or tasks that are within the students' zone of proximal development. The scaffolding approach allows student to try new ways of thinking and interacting. It is important to know that children will benefit and learn from challenging interactions with adults as well as peers who are more skilled than they are. Scaffolding can be accomplished through multiple formats, including the careful selection of examples that progress from less difficult to more difficult, the purposeful separation of highly similar and potentially confusing facts and concepts, the strategic sequencing of tasks that require learners to recognize and then produce a response, or the additional information that selected examples provide, such as highlighting the digits used in a division problem. For example, a young child or a child with physical disabilities likely would need assistance when

learning how to use a playground slide. At first an adult might carry the child up the steps and slide with the child several times. Then some of the scaffolding or support would be removed when the adult placed the child on the lower portion of the slide and allowed him or her to slide with little guidance. The adult would continue to remove the scaffolding as the child demonstrated that he or she could slide longer distances successfully without support.

Decisions about scaffolding is determined by what the students(s) understand, internalize what the teacher wants them to understand. The relationship between the teacher and student(s) determined the type scaffolding needed and how effective or useful the scaffolding used is. Instruction becomes a kind of cooperative learning between the teacher and the student(s) allowing the flow of understanding to continue. Scaffolding involves continuous interaction between the teacher and his/her student(s), quick decisions about the tasks they are to complete, as well as what kinds of assistance the students need, as well as deciding what amount of support is needed to allow the students to build on their knowledge and understanding. Scaffolding instruction must be planned carefully. First, the needs of students must be identified what is the shared understanding. Second, strategies or tasks must be presented in a way that clearly defines the teachers' rule as well as the role of the student. Finally, identify and create a guide for discussions so there is no confusion. Teaching with the use of scaffolding addresses concerns about instruction that has become fragmented or broken up into so many chunks, that the students become confused last and disinterested. Some types of scaffolding may incorporate the use of concrete prompts, cues cards, modeling, cooperative learning etc. The teacher may use Vygostsky's theory that a student will not be successful alone but can be successful with the aid of scaffolding provided by more knowledgeable other.

Scaffolding must begin as soon as a new concept is introduced and if done correctly, very little if any assistance is given in the end. Scaffolding must be decreased slowly; making sure that the student's has bridged the gap between what he knew and what he has learned. It must be consistent, temporary, supportive, flexible and appropriate for the students.

1.2.12 MATHEMATICS EDUCATION IN THE SCHOOLS OF KERALA

The importance and antiquity of education in Kerala is underscored by the state's ranking as among the most literate in the country. The local dynastic precursors of modern-day Kerala made significant contributions to the progress on education in Kerala. There were many *sabha mathams* that imparted Vedic knowledge. Apart from *kalaris*, which taught martial arts, there were village schools run by *Ezhuthachans* or *Asans*.

Kerala school of astronomy and mathematics was founded by Madhava of Sangamagrama in Kerala, which included among its members: Parameshvara, Neelakanta Somayaji, Jyeshtadeva, Achyuta Pisharati, Melpathur Narayana Bhattathiri and Achyuta Panikkar. The school flourished between the 14th and 16th centuries and the original discoveries of the school seems to have ended with Narayana Bhattathiri (1559–1632). In attempting to solve astronomical problems, the Kerala School independently created a number of important mathematics concepts. Their most important results—series expansion for trigonometric functions—were described in Sanskrit verse in a book by Neelakanta called *Tantrasangraha*, and again in a commentary on this work, called *Tantrasangraha-vakhya*, of unknown authorship. The theorems were stated without proof, but proofs for the series for sine, cosine, and inverse tangent were provided a century later in the work Yuktibhasa (1500-1610), written in Malayalam, by Jyesthadeva, and also in a commentary on Tantrasangraha. Their work,

completed two centuries before the invention of calculus in Europe, provided what is now considered the first example of a power series (apart from geometric series). However, they did not formulate a systematic theory of differentiation and integration, nor is there any direct evidence of their results being transmitted outside Kerala.

Schools and colleges are mostly run by the government, private trusts, or individuals. Each school is affiliated with either the Indian Certificate of Secondary Education (ICSE), the Central Board for Secondary Education (CBSE), Kerala State Education Board or the National Institute of Open Schooling (NIOS). English is the language of instruction in most private schools, while government run schools offer English or Malayalam as the medium of instruction. Government run schools in the districts bordering Karnataka and Tamil Nadu also offer instruction in Kannada or Tamil languages. A handful of Government Sanskrit Schools provide instruction in Sanskrit supplemented by Malayalam, English, Tamil or Kannada. After 10 years of secondary schooling, students typically enroll at Higher Secondary School in one of the three streams—liberal arts, commerce or science. Upon completing the required coursework, students can enroll in general or professional degree programs. Kerala topped the Education Development Index (EDI) among the major states in India in year 2006-2007.

Secondary school mathematics in Kerala follows the curriculum initiated by NCERT, New Delhi. Activity based approach is using for the curriculum transaction. Every month, one day there is training for mathematics teachers in this regard. Each year, there are two common written exams for 80 marks each, conducted by Board of Public Instruction, Government of Kerala. The remaining 20 mark is given by internal assessment by the concerned teacher.

Mathematics learning is very important in School education because it is a subject that develops and trains an individual's fundamental mind. But mathematics classrooms are dull, bored and the majority of the students find it as a difficult subject. This is because of today's instruction still confirms to a mechanical routine, continuing to be dominated by the old setting evil of verbalism. In the teaching of mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of mathematical computations.

How far this is possible in a normal classroom teaching, is a big question. Since the understanding level of different ability level of students is different, to make them understand in a normal classroom is a herculean task. The study focuses on this problem in such a way that differentiated instruction could be a solution for this.

1.3 RATIONALE FOR THE STUDY

The teaching and learning of mathematics have always been a matter of central concern in educational research. Since mathematics is a fundamental subject in school curricula, the desire to improve the effectiveness of teaching has stimulated a broad range of studies designed to understand the nature and development of mathematical abilities and the teaching strategies.

The subject mathematics is of great value: aesthetic, utilitarian and social. Mathematics sets the path to self-actualization. But mathematics is not a subject of choice for many students. Majority of students are afraid of mathematics and they develop a phobia towards it. Results of X standard students belong to Kerala Board of Public Instruction of few years show the true story. Failure in mathematics is very high in every year. For the last few years the percentage of failure in mathematics varied from 75% to 90% (Directorate of Public Instruction, Government of Kerala).

Also in secondary level, the students understanding about the basic concepts of mathematics doesn't meet the expected level (Sasidharan, 1992; Pushpanadham, 1996 & Rachana, 2009). So the research in mathematics education is a major concern.

Ability grouping increases student achievement by reducing the disparity in student ability levels. Ability grouping allows the teacher to increase the pace and raise the level of instruction for high ability students, and to provide more individual attention, repetition, and review for low ability students. While most of the people assume that students will learn better if they are grouped together with those who have similar capabilities, research has shown that putting children into separate classes to accommodate their differences from early school years is neither necessary nor very effective. But Bracha and Shlomit (2008) and Yvette (2007) proved that it plays a major role in secondary level for enhancing the achievement and motivation. On contrary Slavin (1990), while examining the effects of ability grouping on achievement of secondary students (middle, junior high, and high school), reported that in comparisons of ability grouping and heterogeneous grouping over periods of from one semester to five years, overall achievement effects were found to be essentially zero at all grade levels. But because of the different characteristics of high, average and low ability students, different instructional strategies are necessary in teaching of mathematics (Saju, 2005). Ability grouping is practicing in different countries with different forms. In Britain, the trend has been towards the increased setting (Boaler, Dylan & Brown, 2000). In U. S. A., grouping by subject has become more typical than streaming (Loveless, 1998). In France, ability grouping is not permitted (Greenway, 1999), while the British Government has endorsed and promoted ability grouping for the past decade (Andrews, 2001). Now in Kerala, inclusive education is practicing.

Students develop attitude towards mathematics through the instructional method that adopted by the teacher in the classroom. Kulik, J. and Kulik, C. (1982) and Kulik, C. (1985) reviewed the research regarding effects of grouping on attitude and self-esteem. They found that ability grouping in a subject resulted in a better attitude toward that subject but did not change attitudes about school. So the attitude towards mathematics is also a concern. Recent policy of NCERT, National Curriculum Framework for School Education (NCF, 2005), is also categorically emphasize the importance of differentiated instruction. Researcher has not come across any study on differentiated instruction and its impact on academic achievement and attitude towards mathematics. So the researcher conducted a study with the following research questions.

1.4 RESEARCH QUESTIONS

The research questions are:

- How will differentiated instruction based on ability grouping affect the academic achievement in mathematics?
- To what extent differentiated instruction can develop attitude towards mathematics among students?
- Whether the differentiated instruction in mathematics enhances students learning?

1.5 STATEMENT OF THE PROBLEM

The problem entitled as "effectiveness of differentiated instruction based on ability grouping on the academic achievement in mathematics among the IX standard students in Kerala"

1.6 OBJECTIVES OF THE STUDY

The objectives of the study are:

- To develop differentiated instructional designs based on ability grouping for teaching mathematics in Kerala at standard IX.
- To implement the differentiated instructional designs in individual ability groups of IX standard students in mathematics.
- To study the effectiveness of differentiated instruction based on ability grouping with respect to the academic achievement in mathematics among IX standard students in Kerala.
- To study the effectiveness of differentiated instruction based on ability grouping with respect to the attitude of students towards mathematics.

1.7 OPERATIONAL DEFINITION OF THE TERMS USED

1.7.1 ABILITY GROUPING

Ability grouping refers to the grouping of students based on their achievement scores in mathematics in the previous year's final examination and the scores obtained from the ability test in mathematics conducted by the researcher. The ability test includes Kerala University Test of Spatial Ability (1982), which was developed and standardized by N. P. Pillai, A. S. Nair and M. P. Ouseph, Kerala Test of Perceptual Speed (1985), which was developed and standardized by A. Sukumaran Nair and N. Krishnakurup and Kerala University test of Numerical Ability (1982), which was developed and standardized by N. P. Pillai, A. S. Nair and A. Indira Bai.

1.7.2 DIFFERENTIATED INSTRUCTION

Differentiated instruction refers to the instructional designs that were developed by the researcher for the students of high, average and low ability groups.

1.7.3 ACADEMIC ACHIEVEMENT

Academic achievement refers to the score obtained in an achievement test in mathematics which was constructed and standardized by the researcher.

1.8 DELIMITATION OF THE STUDY

The study is delimited to the IX standard students of Kerala Board of Public Instruction, Government of Kerala.

1.9 HYPOTHESES OF THE STUDY

The hypotheses in this study are:

- There is no significant difference in the academic achievement in mathematics among the IX standard students in ability groups when taught by differentiated instruction and the students in mixed ability group when taught by traditional method of instruction.
- There is no significant difference in the academic achievement in mathematics among the IX standard students in high ability group when taught by differentiated instruction and the high ability students in mixed ability group when taught by traditional method of instruction.
- There is no significant difference in the academic achievement in mathematics among the IX standard students in average ability group when taught by differentiated instruction and the average ability students in mixed ability group when taught by traditional method of instruction.

- There is no significant difference in the academic achievement in mathematics among the students of standard IX in low ability group when taught by differentiated instruction and the low ability students in mixed ability group when taught by traditional method of instruction.
- There is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of high ability group.
- There is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of average ability group.
- There is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of low ability group.
- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in ability groups and the students in mixed ability group when taught by traditional method of instruction.
- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in high ability group and the high ability students in mixed ability group when taught by traditional method of instruction.
- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in average ability group and the average ability

students in mixed ability group when taught by traditional method of instruction.

- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in low ability group and the low ability students in mixed ability group when taught by traditional method of instruction.

1.10 SCOPE OF THE STUDY

The effects of different teaching methods on achievement in mathematics was experimented by many researchers. In this study the researcher tried to find the effectiveness of differentiated instruction based on ability grouping on the academic achievement in mathematics among the IX standard students in Kerala.

Researcher formed three ability groups' namely high ability group, average ability group and low ability group, and a mixed ability group, a mix of all ability level students, based on ability test scores. The ability groups treated as experimental groups and mixed ability group treated as control group. The academic achievement scores of students in ability groups and mixed ability group were subjected to analysis of covariance to determine the effect of differentiated instruction on academic achievement in ability groups over mixed ability group.

The pre and post attitude test scores of students in different ability groups (high, average and low) in ability groups were compared in order to check whether if there is any significant affect of differentiated instruction on attitude towards mathematics in ability groups.

Finally the attitude scores of students in ability groups and mixed ability group were subjected to analysis of covariance to

determine the affect of differentiated instruction on attitude towards mathematics in ability groups over mixed ability group.

1.11 ORGANIZATION OF THE REPORT

The study is arranged in five chapters. In c*hapter I,* the introduction, conceptual framework, rationale, research questions, statement of the problem, objectives of the study, operational definition of the terms used, delimitation of the study, hypotheses and the scope of the study are included in this chapter

Chapter II gives a review of related literature. Some of the related researches carried out by other research workers in this field are mentioned in this chapter.

Chapter III presents a detailed account of the methodology followed by the researcher. The variables, design, description of tools used and data collection procedures are discussed in this chapter.

Chapter IV analyzes the data collected using suitable statistical techniques. The interpretation of the results is also highlighted in the fifth chapter titled, 'Analysis and Interpretation of Data'.

The last chapter, *chapter V* gives the conclusions of the study. A summary of the findings and the conclusions derived are mentioned. A brief note about the study is given in this chapter along with the suggestion for further study. The hypotheses, objectives and methodology are also given in brief.

References and appendices are given at the end.