CHAPTER - I

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Success in mathematics is central to a good education. The better educated a society, the more successful the society. Proponents of computer technology in education argue that it makes learning easier, more efficient and more motivating (Schacter & Fagnano, 1999).

Computer based instruction is an educational medium in which an instructional content or activities are delivered through the computer. Great emphasis is given to the computer based instruction in the curriculum of education of the developed countries. The main purpose of using computer technology is to train individuals to cope with the fast developing and changing science world and also helps them to utilize the recent technologies in every field. With the rapid development of information and communication technology, the use of computers in education has become necessity. The use of computers in education provides the students with a more suitable learning environment, serves to create and sustain interest and helps in increasing the students’ motivation level. Hence, the use of computer technology plays a very important role in the teaching and learning process (Isman, Baytekin, Balkan, Horzum & Kiyici, 2002).

With the advancement in technology, computers began to be used in educational environments to develop audio and visual materials such as simulation and animation. The use of computers in the teaching and learning activities to integrate science and technology is defined as computer based instruction. The computer based teaching has an impact on the development of the educational technology to a great extent and this has resulted in the production of the instructional packages for the computer based instruction. The primary purpose of the educational instructional packages is to solve the learning problems in the science courses encountered by the students, to increase their motivation, achievements and to protect them against the negative effects of the rote-memory based educational system. The teachers used computer instructional packages as complementary materials for taking notes about their students and observations, making tables, developing materials, doing calculations and preparing simple educational software. These are used as a teaching material in the teaching as a part of a subject or the whole subject (Alkan, Deryakulu & Simsek, 1995; Isman, 2005).

According to Alessi and Trollip (2001), “It is possible to divide educational software into five different types such as tutorial, drill and practice, educational games, simulation and
According to Ozmen (2004), “The techniques such as presentation, demonstration, practice and evaluation of learning should be used with some classroom activities for effective and productive teaching”. According to Ozmen (2008), “The use of computer technology enables learners to be active in the learning process, to develop problem solving skills, to construct knowledge and to discover alternative solutions”.

Computer based instruction is one example where programme instruction has been combined with powerful media and technology to produce expensive and impressive learning systems. In this case, the monitoring and feedback functions of a teacher are handled by the computer. Computer instruction is based on the same principles as the ordinary programmed instruction but students work from computer terminals. They observe displays shown on monitors or typed on a computer output, instead of programmed textbooks or workbooks. Students type information into the computer or respond to it by pressing the related keys. In addition to manipulating interesting, sophisticated and responding equipment, the students find that they cannot cheat, as answers are given only to the student’s responses. It also permits the students to proceed according to their abilities and pace of learning (Sharma 2006, p. 502).

Computer based instructional material helps students to develop information and problem solving skills, to be active in the learning process and to find alternative solutions of the problems, which further give rise to positive changes in the lives of people. The use of problem solving skills is inevitable at every stage of our daily lives. As a result of the advancement in computer technology, it is essential to use computer technology to find the solution of educational problems. The various advantages of computer based instruction are (Sharma 2006, p. 165):

- **Immediate Feedback**: Students remains active as well as immediate feedback keeps students interacting and eager to keep trying.
- **Active Participation**: Computer based instruction helps the students to participate actively especially in case of weaker students because they often remain passive in lectures.
- **Patience**: The computer waits patiently for an answer and does not express annoyance with wrong response.
- **Interactive Graphics**: Interactive graphics make it possible to sample many more illustrations than could easily be shown in a textbook.
- **Realistic**: Mathematical calculations can be done as readily for realistic examples than can be solved analytically.
Introduction

- **Accurate**: Large volume of data can be handled with accuracy.
- **Variety**: The novel technique provides enrichment of a course through added variety.
- **Reduced Learning Time**: Interactive technologies reduce learning time. Students can move through the program at their own pace, skipping areas that are familiar with and concentrating on ones in which students are weak.
- **Increased Retention**: Students retain information longer than with passive learning because computer based instruction requires participation of the students.
- **Accessibility**: A computer is available around the clock unlike the teacher.
- **Consistent, Current Content**: Computer assisted instruction equipment does not tire and always delivers content in a consistent and reliable manner. To ensure timeliness and accuracy, the software is updated regularly.
- **Safety**: Students can practice assessment and other clinical skills without jeopardizing a patient.
- **Enhanced Motivation**: Computer based instruction also motivates the children to explore new areas of interest and actively seek to broaden the knowledge.

Thus, computer based instruction refers to instruction or remediation presented on a computer. Educational computer programs enhance teacher instruction in many ways. Computer programs can illustrate a concept through animation, sound, and demonstration and in this way, these computer programs are interactive. They allow students to progress at their own pace and work individually or solve problem in a group. Computers programs also provide immediate feedback and letting students to know whether their answer is correct. If the answer is wrong, the program shows students how to correctly answer the question. Computer assisted instruction improves instruction for students with disabilities because students receive immediate feedback and do not continue to practice the wrong skills. In addition, computers capture the students’ attention due to interactive programs and engage the students’ spirit of competitiveness to increase their scores. Also, computer assisted instruction based at the students’ pace and it does not move ahead until students have mastered the skill. Computer programs provide differentiated lessons to challenge students.

The use of computers in education is growing at a rapid rate. One of the main advantages of computer based education is the ability to provide immediate feedback on individual responses. Feedback is any message generated in response to a learner’s action. The most important outcome of feedback is to help learners to identify their errors and
become aware of mistakes. According to Cohen (1985), feedback component is more instructionally powerful feature for further learning (p. 33).

Computer provided feedback would seem to have several advantages. First of all, computers can tirelessly provide feedback in response to student work. This feedback remains accurate, unbiased and nonjudgmental irrespective of student characteristics or the nature of the student response. Thus, computer based feedback can be adapted to the learning styles and needs of each individual student. Attention to feedback is likely to be even more critical in computer based instruction than in traditional classroom instruction because computer based instruction application typically provides a learning environment in which the student works individually having little human interaction. So, the success of computer based instruction depends on the quality and appropriateness of feedback provided to learners rather than what is presented or encountered (Mason & Bruning, n.d.).

1.1 COMPUTER BASED INSTRUCTION

There are two basic characteristics of computer assisted instruction. The first is that the computer can evaluate students' responses instantly and indicates whether the response is correct or incorrect on the basis of predetermined key words identified within it. When the student’s answers correspond to the anticipated incorrect answers, then the computer gives corrective hints or offers general hints when the answer does not relate to any of the anticipated in correct answers. It would also call for a modified or new answer. In this way, every student is involved in the learning process as different from a conventional classroom where only a small percentage of the students respond to the teacher’s questions. Each student responding and receiving necessary feedback through computer assisted instruction is led towards the goal of effective learning. Secondly, the computer can individualize instruction in a number of specified ways. Instruction can be individualized according to differential aptitude, achievement and interest. The computer makes note of the learner’s performance and progress and on the basis of the evaluation of his ongoing achievement and as per his needs, it can modify his programme for further learning. The great asset of the computer is its instant response and its flexibility to suit the learners’ needs and requirements through tutorial interaction and dialogue (Sharma 2006, p. 499).

Computer based instruction is one of many acronyms applied to educational or instructional software. Computer based instruction is the term used in academic areas such as reading, writing and mathematics skills for students. Additionally, it is the broadest terms and
Introduction

can refer to virtually any kind of computer use in educational settings, including drill and practice, simulations, tutorials, instructional management, programming, database development, supplementary exercises, writing using word processors and other applications (Cotton, 1991).

Computer based instruction has the potential to dramatically extend education around the world. Not only do these computers provide a means for disseminating scholarly articles and electronic books, but they can also be used to deliver quality instruction. Computer based instruction offers several advantages over traditional education programs. Reduced delivery cost is the single greatest advantage of computer based instruction. Internet based or stand-alone learning modules can be distributed to the user at little or no cost. The two major costs associated with computer based instruction are the development of instructional media and the capital costs of the computers. Both of these costs can be minimal when considering the cost per user. Time efficiency is another significant advantage of computer based instruction. Students can access learning modules at their own convenience instead of waiting for sporadic and infrequent training sessions. New modules can be added to the program and distributed instantly.

Computer based instruction helps in controlling the quality of instruction. A central agency can maintain the consistency of the program to ensure that each learning module builds on previous instruction. Computer based instruction reaches all students directly. It is not meant to replace face-to-face instruction. This type of instruction is meant to augment traditional education programs. Education is the process of instruction aimed to develop the knowledge, skill, attitude or character of individuals to prepare them to live a meaningful life. To make the student-centered learning environment more effective, new innovative techniques and technology should be used in education. Because technology has the ability not only to incorporate the essential content of instruction, but also to move students to higher order thinking and teach lifelong learning skills. The elements of a rationale for using technology in teaching are as follows:

(i) Technology provides motivation for students by gaining learner attention, engaging the learner through production work, increasing perceptions of control.

(ii) Technology offers unique instructional capabilities such as linking learners to information and educational, helping learners visualize problems and solutions, tracking learner progress, linking learners to learning tools.
Technology gives support for new instructional approaches such as: cooperative learning, shared intelligence, problem solving and higher level skills.

Technology increased teacher’s productivity by freeing time to work with students by helping with production and record keeping tasks, providing more accurate information more quickly.

Numerous research studies have documented the effectiveness of computer based instruction: students often have higher academic achievement and better attitudes toward their schoolwork than is true for students taught with more traditional methods (Kulik, Kulik & Cohen, 1980; Lepper & Gurtner, 1989; Merrill, Hammons, Vincent, Reynolds, Christensen, & Tolman, 1996; Roblyer, Castine & King, 1988; Tudor, 1995). Furthermore, students studying academic subject matter on a computer may gain an increased sense that they can control their own learning, thereby developing more intrinsic motivation to learn (Swan, Mitrani, Guerrero, Cheung & Schoener, 1990). Computers offer several advantages for instruction that we often cannot achieve through any other medium. For one thing, instructional programs can include animations, video clips, and spoken messages-components that are, of course, not possible with traditional printed materials. Second, a computer can record and maintain ongoing data for each of the students, including such information as how far they have progressed in the program, how often they are right and wrong, how quickly they respond and so on. With such data, we can monitor each student’s progress through the program and identify students who are having particular difficulty with the material. And, finally, a computer can be used to provide a instruction when flesh and blood teachers are not available; for example, computer based instruction is often used to deliver instruction in rural areas far removed from traditional school settings (Ormrod, 2000). Using a computer in and of itself, however, is not necessarily the key to better instruction (Clark, 1983). A computer can help students to achieve at higher levels only when it provides instruction that we cannot offer as easily or effectively by other means. With planned and implemented appropriately, computer based instruction help students to process classroom material in effective ways.

1.1.1 MODES OF COMPUTER BASED INSTRUCTION

In computer based instruction, the computer interacts directly with the learners while presenting lessons. It delivers instruction directly to students and allows them to interact with the computer through the lessons programmed in the system. The computer’s ability to engage in instructional ‘dialogue’ with the student while delivering information makes it
adaptable to any number of instructional situations (Sharma 2006, p. 168). It can facilitate various instructional modes which are given below:

(i) **Drill and Practice:** This is one of the earliest forms of instruction, also called exerciser. After the content is taught, basic fact and terminology is reviewed which provides the students with a variety of questions in varied format, helps in practicing the content already taught. The students respond to questions, receive confirmation or correction. The role of computer is to ask question, evaluate student respond, and provide immediate feedback and record student progress. The drill and practice activities form a major component of the teaching learning process in many class rooms and aid in memorization, quick recall or identification or improving manipulative skills. This mode is to make sure that concept, rule and procedure have already been learned by the learner. The programme leads the learner through a series of examples to develop dexterity and fluency in using the skill. All correct responses are reinforced. The computer goes ahead only when mastery is achieved by the learner.

(ii) **Tutorial:** In computer based instruction, the tutorial style is an attempt to the computer, the total responsibility for teaching. Tutorial programs are characterized by their ability in presentation of new information, teaching concepts and principles and providing remedial instructions. In tutorials, the role of teachers is to select material and adapt instruction to the students need and abilities and monitor program. The instructions can be tailored to the individual needs and abilities. The computer presents information, asks questions, answers questions, monitor responses, provide remedial feedback, helps in summarizing key points and keep records. In this style, the student is active participant in the teaching learning system and it enables him to achieve higher order cognitive objectives. So, in the tutorial mode, information is given to the students in small units followed by a question. The students’ response is analysed by the computer and appropriate feedback is given.

(iii) **Gaming:** It is a competitive drill and practice in a motivational format either played individually or in small groups. The teacher introduces the subject and presents background and guides debriefing. The computer act as a competitor, judge, score keeper and provides game playing environment based on rules. Games are based on the principles of learning while having fun. It makes the students learn facts, strategies and skills. It evaluates choices, allows the student to compete with himself or with others or with computer. It develops the ability of intuition, deduction and reasoning and is excellent mode to encourage student
participation. Gaming mode can or cannot be instructional. It is mostly recreational in purpose, while sometimes it teaches through games.

(iv) Simulations: Simulations provide the feeling of real life situations. It models the real life situations based on realistic models either as individual or in small groups. The role of teacher is to introduce subject, present background and guide debriefing. The computer plays role in delivering results of decisions, maintains the models and its database. The students practice decision making, make choices, receive results of decisions and evaluate decisions. It provides insight into processes, relationship and interaction between parameters. It provides inductive thinking. Hence in simulation mode, the learner confronts a scaled down approximation of a real-life situation. Through specific input, computers develop models of processes or structure. Simulated conditions are shown on the computer screen such as working of the circulatory system of the human body or the effect of interactions on the operation of a system or other models from biology, mathematics or ecosystem. Thus, this mode allows realistic practice without the expense of risks otherwise involved.

(v) Problem Solving: The role of teacher is to assign problems, assist students and check results. The students may make use of database of computer in solving problem. The database may provide them the simulated experimental data or information of material testing, measurement procedures, design tools etc. During this phase, the computer will monitor student’s progress, maintain database and provide feedback. Students define the problem, set up the solution and manipulate variables with trial and error method.

(v) Discovery Mode: In this mode inductive approach to learning is taken up, that is, the problems are resented and the learner solves those problems through trial and error. It approximates to laboratory learning and the real-life-learning outside the classroom. The main of the approach is the deeper understanding that results from discovery and solving a complex problem.

Computer based instruction is defined as an interaction between students, a computer controlled display and a response entry device for the purpose of achieving educational outcomes (Bhatt & Sharma, 1992). Computer instructions have now taken so many dimensions that it can no longer be considered as simple derivative of the teaching machine or the kind of the programmed learning that Skinner introduced (Hilgard & Bower, 1977). According to Senemoglu (2003), “Computer based instruction enables the children to progress at their own pace and provides them with appropriate alternative ways of learning by
individualizing the learning process”. “Computer based instruction is the use of computers in the teaching and learning activities” (Brophy, 1999 as cited in Serin, 2011).

1.2 ACHIEVEMENT IN MATHEMATICS

Mathematics achievement plays a very important role in the attainment of the ideal of harmonious development of a student. With the growing advancement in science and technology, mathematics has become so important that every parent today sets high goals for the students to achieve. Achievement thus means all those behavioral changes, which take place in the individual as a result of learning experience of various kinds. Mathematics achievement refers to the degree or level of success or proficiency attained in some specific areas concerning mathematics. In general it refers to the score obtained in the annual exams.

Predictors for students' mathematical achievement are classified under two categorical factors: the psychological and the mathematical factors. Three independent variables of the psychological factors understudied are memory, interest and attitude towards mathematics. The other mathematical factors are mathematical language, thinking ability, mathematical concept and computational skills (Peng & Kheong, 1996).

- **Psychological Factors**
  
  (i) *Attitude towards Mathematics:* Attitude indicates a person's negative or positive response to certain situations, objects, concepts, institutions or other persons (Aiken, 1985). Positive relationships are found between attitude and mathematics achievement (Bassham, Murphy & Murphy, 1964; Capps & Cox, 1969; Duckworth & Entwistle, 1974).

  (ii) *Interest in Mathematics:* Aiken (1985) distinguishes interest from attitude. Interest in mathematics refers to the willingness of students to spend time on the subject, which may take the form of reading more about it or participating in mathematical activities. Attitude on the other hand, refers to an expressed liking or dislike of the subject. Sjoberg (1984) developed a model which explains the relationship between achievement and the interest variable. Interest in mathematics contributed only 4.2% variance to the prediction of mathematics achievement (Prowsri & Jearakul, 1986).

  (iii) *Memory:* Memory involves the retention and retrieval of materials and activities. It is also believed that memory is associated with intelligence. The more intelligent subjects are able to remember more and with greater speed than less intelligent subjects (Howe, 1983).
• Mathematical Factors

(i) Logical Thinking Ability: Logical thinking is a combination of various operations: combinatorial, proportional, coordination of two systems and the relativity of motion or acceleration, notion of probability and correlation (Inhelder & Piaget, 1958). Positive correlation between logical thinking ability and students' achievement was found in numerous studies (Suppes & Binford, 1965; Tobin & Capie, 1984; Prowsri & Jearakul, 1986).

(ii) Computational Skills: Computational skills are important because they help children to understand mathematical concepts better. They also help pupils to recognize generalizations (Hamrick & Mckillip, 1978). Numerous studies have reported positive significance of computational skills with mathematics achievement (Chase, 1960; Caldwell & Goldin, 1979; Ballew & Cunningham, 1982; Muth, 1984).

(iii) Mathematical Language: Shuard and Rothery (1984) explain that there are mainly three categories of mathematical text. The first contains words which have the same meaning in both mathematical English and ordinary English. The second has words which have a meaning only in mathematical English, for example, 'hypotenuse' and 'parallelogram'. The last involves words which occur in both ordinary English and mathematical English but possess a different meaning in mathematical English from their meaning in ordinary English, for example words such as 'means' and 'significant'. There were research studies which found a weak correlation between reading ability and mathematics achievement (Hansen, 1944; Chase, 1960; Balow, 1964). However, there were also findings which found positive relationships between reading ability and mathematics achievement (Cuevas, 1984; Muth, 1984).

(iv) Mathematical Concept: 'Concept' is a "guiding force" and a dynamic process for scanning perceptual data in the light of past experience (Wallace, 1965). There were studies which reported positive correlations between concept and mathematics achievement (Chase, 1960; Caldwell & Goldin, 1979). Research studies have found that mathematical concepts are major contributors to successful problem solving (Muth, 1984).

Achievement is the extent to which learner is profiting from instructions in a given area of learning (Crow & Crow, 1956). Achievement is one which can establish whether a student has a command of the material which teachers have taught (Cronbach, 1984). An achievement test is one which assesses the knowledge of some school subjects. What a person has attained in the past is usually quite a good indicator of his future ability (Aiken, 1985). Torres (1993) defined achievement as the attained ability or degree of competence in
school tasks usually as measured by standardized tests and expressed in age as grade units based on norms derived from a wide sampling of pupils' performance. It is the outcome of general and specific learning experiences. Ladson-Billings (1999) stated that at its best academic achievement represents intellectual growth and the ability to participate in the production of the knowledge. At its worst, academic achievement represents inculcation and mindless indoctrination of the young into the cannons and orthodoxy of the old. Achievement tests how well students have mastered the subject matter in a course of instruction (Megargee, 2000).

1.3 MATHEMATICS SELF-EFFICACY

Perceived self-efficacy is defined as people's beliefs in their capabilities to produce effects. Self-efficacy has affected human functioning through four major psychological processes such as cognitive, motivational, affective and selection (Bandura, 1994). The transition from rote performance to information age skills placed a premium on the role of personal efficacy in educational self-development (Bandura, 2004). The perceived self-efficacy includes people's beliefs in their capabilities to produce given attainments. The perceived self-efficacy also influences human self-development, adaptation and change. Mathematics self-efficacy was defined as an individual’s beliefs about how he or she would perform a specific math task or in a specific mathematics or related course (Bandura, 2005).

Pajares (2002) assumed that personal self-efficacy beliefs were the very foundation of human agency, vital forces in their success or failure in all endeavors and critical forces in their academic achievement. Like Bandura (1994) and Marsh, Walker and Debus (1991), Pajares (2002) emphatically differentiated self-efficacy and self concept. Ferry, Fouad and Smith (2000) also concluded that parental encouragement in mathematics and science not only influences achievement but also influences self-efficacy and grade expectation.

Self-efficacy has the potential to facilitate or hinder mathematics learner’s motivation, use of knowledge and disposition to learn. Self-efficacy is the judgements that individual make about his potential to learn successfully and the belief in his own capabilities. The choices an individual make, the effort put forth by an individual and how long an individual persist are influenced by self efficacy (Bandura, 1997; Schunk, 1996). Perceptions of self-efficacy come from personal accomplishments, vicarious learning experiences, verbal persuasions and physiological states (Bandura, 1986; Ingvarson, Meiers & Beavis, 2005; Tanner & Jones, 2003). A self-efficacy impact on a learner’s potential to succeed (Bandura,
1977). An insight into the self-efficacy of their learners is a valuable tool for mathematics educators.

It is important for educators to know how their learners feel, think and act toward mathematics. The influence of values, attitudes and personality characteristics on achievement outcomes and later participation in the learning of mathematics are important considerations for mathematics educators (Yates 2002, p. 4). One way to gain insight into how their learners feel, think and act toward mathematics is to examine their psychological domains of functioning: the affective, the cognitive and the conative (Tallon, 1997). It is important to examine each domain as a student may feel efficacious within the affective domain but less confident within the cognitive domain.

Affect is a student’s internal belief system (Fennema, 1989). The affective domain includes students’ “beliefs about themselves and their capacity to learn mathematics; their self-esteem and their perceived status as learners; their beliefs about the nature of mathematical understanding; and their potential to succeed in the subject” (Tanner & Jones 2003, p. 277). Tanner and Jones (2000) described that the cognitive domain considers students’ awareness of their own mathematical knowledge, their strengths and weaknesses and their abstraction of processes and their development of links between aspects of the subject. Cognition refers to the process of coming to know and understand the process of storing, processing and retrieving information. So this factor describes thinking processes. Conation refers to the act of striving to purposeful actions and it is about staying power and survival. Conation includes students’ dispositions to strive to learn and the strategies they employ in support of their learning.

Confidence in learning mathematics and the perceived usefulness of mathematics, conceptual forerunners to mathematics self-efficacy and outcome expectations, have consistently been found to predict mathematics-related behavior and performance (Hackett, 1985). Self-efficacy refers to students’ beliefs about their capability to learn or to perform effectively; outcome expectations refer to students’ beliefs about ultimate end of performance. Students with high sense of self-efficacy tend to use cognitive and meta cognitive strategies and persist in difficult or uninteresting tasks. Intrinsic interest or value and goal orientation essentially concern students’ reason for performing a task. Students’ beliefs in their efficacy to regulate their own learning and to master academic activities determine their level of motivation, aspirations and academic accomplishments (Bandura, 1993). High academic self-
efficacy is shown to be a very strong predictor of academic achievement (Bandura, 1997; Moulton, Brown & Lent, 1991; Pajares & Miller, 1994).

Perceived academic self-efficacy is defined as personal judgements of one’s capabilities to organize and execute courses of action to attain designated types of educational performances. Self-efficacy level refers to variations across different levels of tasks such as increasingly difficult mathematics problems. Self-efficacy generality implies the transfer of self-efficacy beliefs across activities such as different academic subject matters. Self-efficacy strength in academics is measured by degrees of certainty that one can perform given tasks (Zimmerman, 1995).

Self-efficacy beliefs have strong predictive role in mathematics problem solving (Pajares & Miller, 1994; Pajares & Kranzler, 1995). The path analysis of Pajares and Miller (1994) agreed that self-efficacy was an antecedent of the learning experience. Zimmerman and Cleary (2006) also differentiated self-efficacy from self-concept, self-esteem, outcome expectations and perceived control. Self-efficacy had four characteristics. Firstly, self-efficacy concerned perceived capabilities to perform an activity rather than on personal or psychological characteristics. Secondly, it was domain-specific, context-specific and task-specific. Thirdly, it was dependent on mastery performance rather than normative criteria. Fourthly, self-efficacy beliefs were typically assessed prior to engaging in a particular task or activity. Self-efficacy as it pertained to self-referent thinking involved a three-fold cycle: Forethought (processes preceding action), performance control (processes occurring during learning) and self-reflection (processes that occur post-performance). The forethought phase included goal setting and strategic planning while the self-reflective phase included self-evaluation and attributions (Zimmerman & Cleary, 2006).

Mathematics self-efficacy was differentiated from self-esteem. Pajares (2002) differentiated self-efficacy and self-esteem (or self-concept). He found self esteem instead pertains to the evaluation of self-worth which depends on how well one's behavior matches personal standards of worthiness and how the culture values the attributes one possesses. Bandura (2006) found self-efficacy as a predictive of future academic successes. In related research, authors have related self-efficacy to attitude, achievement and sources that affect mathematics self-efficacy such as:

(i) Fear of Mathematics: According to Ufuktepe and Ozel (2002), “Students acquire a general fear of mathematics from the society around them. Anxiety and fear of mathematics impedes a student’s success with mathematics. The study from Turkey involved a survey of 500
elementary students who attended a mathematics show encouraging students to understand that the mathematical process is more important than the correct answer. The study showed that teaching styles and learning styles do not always match up, which affects student confidence toward mathematics”.

(ii) Anxiety: According to Taylor and Brooks (1986), “The study with adults in basic education courses indicated that students must first build mathematics confidence by overcoming mathematics anxiety before they are able to find success”.

(iii) Confidence: According to Kloosterman and Cougan (1994), “The interviews conducted on students that posed questions about school and mathematics including whether they were confident in their mathematical abilities. Students in grades 3rd to 6th were more able to articulate their beliefs than younger students. Whether students in grades 1st to 2nd were less confident or simply unable to articulate their beliefs effectively is uncertain. However, in both grade groups, students who enjoyed mathematics were more confident of their abilities”.

According to Bandura (1997), performance successes generally strengthen efficacy beliefs and repeated performance failures weaken efficacy beliefs, particularly if the failures occur early in the course of events and do not reflect lack of effort. A small performance success will often enable individuals to achieve higher accomplishments and to succeed at new activities or in new settings (Bandura, 1997; Williams & Zane, 1989). But performance alone does not provide sufficient information to judge one’s level of capability because many factors that have little to do with ability can affect performance. Perceived self-efficacy is often a better predictor under variable conditions than past performance because efficacy judgements encompass more information than just the executed action (Bandura 1997).

Bandura (1986) contended that mathematics self-efficacy was more predictive of future performance than such global indicators as confidence in learning mathematics. Self-efficacy refers to an individual’s confidence in his or her ability to perform the behaviors required to obtain a desired outcome.

Bandura (1977) defined self-efficacy as individuals’ beliefs regarding their ability to successfully accomplish some tasks. Self-efficacy beliefs influence the development of interests and goal settings both of which serve as the base of the general career decision processes and the process of committing to a vocational choice in particular (Betz & Voyten, 1997). Self-efficacy is an individual’s assessment of his or her ability to cope with given situation (Eysenck, 2000). Self-efficacy is an impression that one is capable of performing in a certain manner or attaining certain goals (Ormrod, 2006). Math self-efficacy has been
assessed as individuals' judgments of their capabilities to perform math-related tasks, to solve specific math problems or succeed in math-related courses (Betz & Hackett, 1983).

According to Hackett and Betz (1989), ‘Mathematics self-efficacy is a situational or problem-specific assessment of an individuals’ confidence in her or his ability to successfully perform or accomplish a particular mathematical task or problem”. Self-efficacy for performance in mathematics tasks has been operationalized in mathematics as a score in the measure of individuals’ self-beliefs about the capacity of performance in some particular aspect of mathematics (Pajares & Miller, 1995). Mathematics self-efficacy is a critical factor in career choice (Kennedy, 1996). Research in academic settings verifies that perceived self-efficacy beliefs contribute independently to intellectual performance (Bandura, 1997). Collins (1982) found that children who had stronger self-efficacy beliefs were quicker to discard faulty strategies, chose to rework problems they missed, solved more problems and did so more accurately than children of equal ability who doubted their self-efficacy.

In higher education settings, Pajares (1996) reports that mathematics self-efficacy of college undergraduates was a better predictor of their mathematics interest and majors than either their prior math achievement or math outcome expectations. Academic self-efficacy influenced achievement directly as well as indirectly by raising students’ grade goals (Zimmerman, Bandura & Martinez-Pons, 1992). Students who believe in their capability of performing academic tasks use more cognitive and meta-cognitive strategies and persist longer than those who do not believe in their capability of performing tasks (Pintrich & Garcia, 1991).

1.3.1 SOURCES OF SELF-EFFICACY

Pajares (2002) called the four sources of self-efficacy i.e. social persuasion, vicarious experiences, mastery experiences and physiological states as social persuasion concerned the social messages received from others. Vicarious experience concerned the effects produced by the actions of others. Mastery experiences were the interpreted results of purposive performance. Physiological states concerned to anxiety, stress, arousal, fatigue and mood. The four sources of self-efficacy (Bandura, 1994) are

(i) Verbal Persuasion or Social Persuasion: According to Bandura (1997, p.101), “Verbal persuasion involves verbal input from others such as colleagues, supervisors and administrators that serves to strengthen a person’s belief that he or she possesses the capability to achieve a desired level of performance. It is easier to sustain a sense of efficacy
especially in times of difficulty, if significant others express faith in one’s capabilities than if they convey doubts”. “Verbal persuasion may be limited in its power to create enduring increases in self-efficacy but it can bolster self-change if the positive appraisal promotes greater effort in the development of skills that subsequently lead to a stronger sense of efficacy. In schools, teachers often receive verbal persuasion in the form of professional development workshops that provide knowledge of a new strategy as well as persuasive claims about its usefulness; unfortunately, this format allows little input from teachers” (Stein & Wang, 1988). Teachers may also receive verbal persuasion in the form of specific feedback or encouragement from a supervisor or colleague designed to convince them that they can successfully implement a new teaching strategy. Verbal persuasion alone may not be a powerful source of self-efficacy; however, in partnership with other sources of efficacy, it may provide teachers the encouragement necessary to expend effort toward realistic goals aimed at strengthening their teaching skills.

(ii) Vicarious Experience: “A second source of self-efficacy is that of observing another person successfully perform the action that one is contemplating. Because teaching lacks absolute measures of adequacy, teachers must appraise their capabilities in relation to the performance of others” (Bandura, 1997). “The observer has the opportunity to appraise his or her own capabilities because the model provides a standard and this can help the observer to set goals for his or her own teaching. The greater the assumed similarity between the observer and the model, the more persuasive will be the belief that one possesses the capabilities to master comparable activities. When an observer watches a successful teaching exchange, he or she is more likely to see the teaching task as manageable. Likewise, when the teaching model fails despite strong efforts, the observer may judge the teaching task to be out of reach. People actively seek proficient models who demonstrate the competencies to which they aspire. Competent models transmit knowledge and teach observers effective skills and strategies for managing task demands through their behavior and by revealing their thinking about the task at hand. Some professional development models provide vicarious experiences through videos of the skill or strategy in action. If the vicarious experience is limited to watching the presenter, it may be only minimally effective at increasing teaching skill” (Joyce & Showers, 1988). However, as part of a comprehensive developmental experience, observing a proficient performance of the skill to be learned can provide valuable information and insight.
(iii) Mastery Experiences: “The most influential source of efficacy information is personal mastery experiences because they provide the most authentic evidence of whether one can master whatever it takes to succeed in a particular field or endeavor” (Bandura, 1997). “Successes build a robust belief in one’s efficacy especially when success is achieved early in learning with few setbacks. Self-efficacy beliefs may be diminished when success is achieved through extensive external assistance, after considerable effort or on a task perceived as easy or unimportant. Failures that cannot be attributed to a lack of effort or to external events are likely to have a deleterious effect on self-efficacy beliefs. This has important implications for teacher professional development. The actual use of the new knowledge presented in a professional development workshop has been shown to contribute to changes in teacher self-efficacy, whereas simple exposure to the material did not contribute to change in teacher self-efficacy” (Ross, 1994). “The competent performance creates a new mastery experience that serves as a new source of self-efficacy that either confirms or disrupts existing self-efficacy beliefs. Over time, the process stabilizes and a relatively enduring set of efficacy beliefs are established that tend to be resistant to change” (Bandura, 1997). “The pre service period, in particular, tends to be a time of learning to teach that is marked by major changes in teacher self-efficacy” (Ross, 1994; Woolfolk-Hoy & Burke-Spero, 2005).

(iv) Physiological and Affective States: When judging their own capabilities, people rely partly on information conveyed by physiological and emotional states (Bandura, 1997). “A person’s level of arousal, whether perceived positively as anticipation or negatively as anxiety, can influence his or her self-efficacy beliefs. Arousal, such as elevated heart and respiratory rate, increased perspiration, or trembling hands, may have enabling or debilitating effects, depending upon whether the situation is perceived as a challenge or a threat (Gregoire, 2003). Moderate levels of arousal when perceived as a challenge can improve performance by focusing attention and energy on the task, whereas high levels of arousal perceived as a threat might interfere with making the best use of one’s skills and capabilities. In the professional development context, exposure to new knowledge and teaching strategies may evoke arousal in the form of interest and curiosity. Initial training experiences may cause nervous anticipation for a teacher, especially if the teacher is to be observed and the performance critiqued. But trying out a new strategy in a supportive workshop setting where encouragement and assistance are available can also help reduce the fear of trying it with a room full of students”.
1.4 MATHEMATICS ANXIETY

Anxiety is a strong negative emotion, accompanied by a sense of unease, worry and intrusive thoughts that cannot be put to rest. Anxiety is one of the most pervasive psychological phenomenon of the modern era refers to persistence distressing psychological state arising from an inner conflict. Anxiety is a psychological poison, which can cause as much damage as a physical toxin. An anxiety raises, performance declines, confidence are eroded and ability undermined. Excessive anxiety is extremely unpleasant and completely unhelpful. The anxiety responses ensured that one does the worse. A certain amount of anxiety is normal, useful and necessary. If it is not channeled and put to use, however, it can be debilitating and also contagious (Neylan, 1962).

Mathematics anxiety refers to a state of uneasiness and distress about mathematics or the taking of mathematics tests. Mathematics provides a very real cause or threat to students, who have not learned how to cope with them. A student who have not prepared for a test will have the fear of failing the test. An excessive fear is certainly destructive and painful, but a reasonable amount of fear in certain situations is beneficial providing motivation to increase learning in order to perform well in the exams. Excessive anxiety results in low self-esteem and poor academic performance (Rapalje, 2006).

1.4.1 CONSEQUENCES OF MATHEMATICS ANXIETY

The consequences of mathematics anxiety are listed below:

(i) Math Anxiety and Attitudes Towards Math: The relationship between math anxiety and attitudes toward math is not surprising. Individuals with high levels of math anxiety have negative attitudes towards math (Ashcraft, Kirk & Hopko, 1998; Ashcraft & Ridley, 2005; Fennema, 1989). Highly math anxious students report low enjoyment of math both in high school and college, see math as less useful than other academic areas, have a lack of motivation to engage in math and have negative attitudes toward math teachers. In meta analysis, both Hembree (1990) and Ma (1999) have shown moderate to strong correlations between math anxiety and (a) enjoyment of math pre-college \( r = - 0.75 \), (b) enjoyment of math during college \( r = - 0.47 \), (c) motivation to engage in math \( r = - 0.64 \), (d) usefulness of math \( r = - 0.37 \), and (e) math teachers \( r = - 0.46 \).

The negative attitudes toward math often lead to math avoidance throughout school, a tendency which Ashcraft and Faust (1994) refer to as “global avoidance” and state that it results in these individuals avoiding educational tracks and career avenues that depend on
math. At high school as well as at college level, math anxious individuals avoid in selecting majors that are viewed as quantitatively intense (LeFevre, Kulak & Heymans, 1992). Math avoidance can result in long term consequences such as deciding not to pursue higher education, being ineligible for advanced education due to insufficient math proficiency and avoidance of careers that are perceived as mathematically laden (Hembree, 1990).

(ii) Math Anxiety and Feeling of Self: According to Ashcraft and Ridley (2005), “Math anxious individuals not only have negative attitudes toward the subject of math but also have negative attitudes about themselves in relation to math. They suffer from low self-confidence in math in both high school and college. The overall self-esteem of highly math anxious individuals is also affected by their anxiety because they often perform poorly in math despite their overall academic achievement level and thus see themselves as less intelligent”. “Perhaps the most frequently studied factor in relation to math anxiety and feeling of self has been self-efficacy. Broadly defined, self-efficacy is an individuals’ situation specific belief that he or she can successfully perform a behavior required to produce a given outcome” (Bandura, 1989). In other words, self-efficacy is ones’ confidence in his or her competence. In the context of mathematics, self-efficacy is ones’ confidence in his or her ability to successfully complete mathematically related tasks. A number of empirical works have shown an inverse relationship between self-efficacy and math anxiety (e.g. Cooper & Robinson, 1991; Meece, Wigfield & Eccles, 1990). Individuals with high levels of math anxiety tends to have low math self-efficacy while highly math anxious individuals do not much confidence in their ability to engage in math with much success.

Another way in which math anxiety related to feelings of self is through stereotype threat. Stereotype threat occurs when the existence of a negative stereotype about members of a disadvantaged group results in members of that group under performing in a particular area (Steele, 1997). Steele (1997) argued that stereotype threat is cued by the mere recognition that a negative group stereotype could apply to oneself in a given situation. Individuals from the group that has stereotypically poor math performance often suffer from stereotype threat and perceive themselves as less competent than their peers. These groups suffer from math anxiety in part due to this stereotype threat and lack of self-efficacy (Osborne, 2001). Likewise Bandura and Locke (2003) state that when a person receives feedback that his or her social group has performed either poorly or well, that person takes on the expectations of the group and adjusts his or her attitudes to align with the performance. For e.g., if a woman is told that other women performed well on a math task, she will also expect to do well on the
task and will have more positive attitudes toward math. Conversely, if a woman is told, either
directly or indirectly, that women are not good at math, she will also expect to do poorly on
the math tasks and will have more negative attitudes about math.

(iii) Math anxiety and performance: A persons’ level of math anxiety does not reflect their
overall level of intelligence. Previous work has shown very small correlations between math
anxiety and scores on measures of general intelligence (Ashcraft, 2002; Dreger & Aiken,
1957). Although individuals with high math anxiety may have average or above average
intelligence their competence in math often suggests the opposite. Achievement scores in
math provide support for this idea; individuals with high math anxiety score lower on math
achievement measures than low math anxious individuals across gender, age, grade and
nationality (Ho, Senturk, Lam, Zimmer, Hong & Okamoto, 2000; Ma, 1999). Perhaps low
performance in math results in people becoming math anxious. The inverse could also be true,
however; perhaps having high levels of math anxiety results in low performance in math.

The three factors related to math anxiety discussed above i.e. attitudes towards math,
feelings of self-worth and performance are cyclical in nature. Math anxious individuals are
perpetuating the belief they hold about their math ability by avoiding exposure to math and
furthering their lack of knowledge and experience with math and math-related activities. This
is followed by poor performance in math which can further bolster their beliefs about their
ability and competence, leading to further avoidance behaviors (Ashcraft & Ridley, 2005).

1.4.2 THEORETICAL PERSPECTIVES OF MATHEMATICS ANXIETY

To uncover the possible factors that contributes to math anxiety, its must to look at
math anxiety from a developmental perspective. It is unlikely that math anxiety is a construct
that emerges in adolescence or adulthood; many types of anxiety disorders prevalent in adults
have their onset in childhood (Kessler, Berglund, Demler, Jin, MeriKangas & Walters, 2005).
Infact, anxiety disorders are the most common childhood psychiatric disorder (Bosquet &
Egeland, 2006) with lifetime prevalence rates ranging from 6% to 15% in epidemiological
studies (Chorpita & Southam-Gerow, 2006). The fact that general anxiety is so common in
children leads one to infer that specific types of anxiety, such as math anxiety, are
experienced by children. The existence of math anxiety in children younger than sixth grade
has been examined in only two known studies (Gierl & Bisanz, 1995; Jameson, 2008) and
was found to be a viable construct in children in both studies. In addition to knowing that
math anxiety occurs in children, it is essential to examine potential explanations for the existence of math anxiety which are given as follows:

(i) Human Agency and Math Anxiety: To understand how and why math anxiety develops in children, one useful perspective to examine is that of Bandura (1989) human agency in social cognitive theory. Children are not completely autonomous creatures who are unaffected by their environment nor are they mechanistic beings who simply transmit input into a behavior. In a model of interactive agency, children learn through triadic reciprocal causation (Bandura, 1986). In other words, three reciprocal factors interact with one another to influence a person’s beliefs and actions. These three factors are Behavior factor, Personal factor and Environmental factor. Human agency or the ability of humans to make choices and impose those choices on the world, affects how these factors interact (Bandura, 1989). The choices that a person makes are influential in the environments into which she places herself, the people with whom she chooses to interact, and the behaviors in which she engages. (Bandura 1977, 1989; Bandura & Locke, 2003) states of all mechanisms of human agency, none is more pervasive than people’s beliefs about their abilities to control events that affect their lives. Psychological mechanisms and procedures, whatever they may be, serve as a means of creating and strengthening self-efficacy (Bandura, 1977).

Self-efficacy is the belief that a person can successfully execute a desired behavior to result in a desired outcome (Bandura, 1977, 1989, 1993; Wood & Bandura, 1989). The strength of this belief has an effect on the persons’ behavior and results in the person either attempting to achieve the outcome or losing motivation and not attempting. Therefore, a person with high self-efficacy believes she is good at something, exerts more effort, perseveres when difficulty arises and chooses to engage similar activities in the future (Bandura & Schunk, 1981). This leads to the highly self-efficacious person having high future performance, positive effect and continuous engagement in said behavior; whereas the low self-efficacious person will have poor future performance and negative affect (Bandura, 1989, 1993; Wood & Bandura, 1989). As Bandura (1993) stated, it is difficult to achieve much while fighting self-doubt (p.118).

Consistent with the perception-performance cycle of anxiety, Bandura (1993) explained the relationship between human agency and anxiety as perceived efficacy to exercise control over stressors play a central role in anxiety arousal. People who believe they can control over threats do not conjure up disturbing thought patterns. But people who believe they cannot manage threats experience high anxiety. Those people view many aspects
of their environment as fraught with danger and they magnify the severity of possible threats and worry about things that rarely happen. Through such inefficacious thinking, such type of people distress themselves and impair their level of functioning (pp.132 -133).

Following this line of connections to more specific constructs demonstrates the utility of viewing math anxiety in conjunction with self-efficacy. The benefit of using Bandura’s conceptualization for understand math anxiety is the potential to gain a better understand of the interaction among personal, environmental and behavioral factors contributing to math anxiety and math avoidance.

- **Personal Factors:** Personal factors central to explaining math anxiety with Bandura’s theory include self-efficacy and gender. The work of Schunk (1981, 1982a, 1983b) with elementary school children has shown the importance of self-efficacy as a factor in children’s math performance and found that lower levels of self-efficacy are related to lower levels of math performance and attitudes even in young children. Schunk (1984) has shown that it is possible to enhance self-perceptions of math-efficacy in students through strategy training. This increased efficacy leads to higher levels of performance, increased persistence and more intrinsic interest in math. Timidity in asking questions in class, shyness, self-distrust and prejudiced ideas such as thinking that only males can be successful in mathematics are some of the personal causes.

- **Environmental Factors:** Steele and Arth (1998) and Oberlin (1982) proposed that using rote memorization without a focus on understand does not allow for accommodation of different learning styles or an appreciation of the real world relevance of mathematics, which can foster feelings of anxiety toward math. Among the environmental factors are negative experiences encountered in class, parental pressure on students, insensitive and pedagogically inadequate teachers, preconceptions about mathematics formed in time (e.g., introducing mathematics as a collection of strict rules starting from early years of educational process) and a teacher centred classroom climate where students are passive.

- **Behavioral Factors:** As previously mentioned, highly math anxious individuals avoid enrolling in elective math courses (Hembree, 1990; Meece, Wigfield and Eccles, 1990) and avoid selecting college majors, which they view as mathematically intense (Ashcraft & Faust, 1994; LeFevre, Kulak & Heymans, 1992). Emotional factors can be listed as teaching strategies not suitable for students’ learning styles, student attitudes, easily giving in, lack of motivation, incorrect thoughts and prejudice students develop against their own mathematical
ability, one’s low perception of self value, lack of self confidence and the way of thinking which asserts that mathematics is not necessary.

(ii) Working Memory and Math Anxiety: “Another perspective from which to examine math anxiety is through the role of working memory, a component of information processing theory of cognition. The working memory model proposes that three systems are responsible for the short term maintenance of information and these three systems are supervised by a central executive. The three systems, the visuospatial sketchpad, phonological loop and the episodic buffer are each responsible for retaining verbal or visual information or for linking information across domains. The central executive is responsible for directing attention to important information, ignoring irrelevant information and coordinating cognitive processes when multiple tasks must be attended to simultaneously” (Baddeley, 1986, 1992, 2000; Baddeley & Hitch, 1974).

“Working memory is limited in capacity, and as more demands are placed on working memory there is less cognitive space available for other tasks. It has been proposed that this limitation in capacity, coupled with highly anxious individuals' inability to ignore irrelevant information, may be responsible for reduced mathematical competence and performance” (Ashcraft & Kirk, 2001; Beilock & Carr, 2005; Beilock, Kulp, Holt & Carr, 2004; Hopko, Ashcraft, Gute, Ruggiero & Lewis, 1998).

According to Eysenck and Calvo (1992), “Intrusive thoughts and worries compete for working memory capacity with the cognitive task at hand. Because of the competition for space in memory work between anxiety and task, performance will decline or processing will slow down. Tasks that require a large amount of working memory capacity are especially susceptible to reduced cognitive efficiency”.

The processing efficiency theory has been applied to mathematics specifically and was found tenable (Ashcraft & Kirk, 2001; Ashcraft, Kirk & Hopko, 1998). Higher levels of math anxiety are related to lower levels of working memory capacity, and this reduction in working memory capacity leads to increased effort to complete math-related tasks as well as worsened performance (Ashcraft & Kirk, 2001). It has also been shown that when under pressure, either through peer pressure to perform well, monetary incentives to perform well or threat of performance evaluation, reduced working memory capacity results in decreased performance (Beilock & Carr, 2005).

While the working memory model provides a reasonable explanation for the relationship between math anxiety and reduced performance, it does not provide an
explanation for the potential underlying causes of math anxiety. It has been questioned whether people with low working memory capacities are more likely to become anxious (Jameson, 2009), but research has yet to examine this question. This theory does, however, give researchers and educators more insight into math anxiety and a possible explanation for the performance consequences of math anxiety.

Individuals with high levels of math anxiety experience a number of negative consequences. Stemming from this anxiety including negative attitudes toward math, avoidance of math, decreased feelings of self-esteem and self-efficacy and reduced performance in math similar to other forms of anxiety, manifestations of math anxiety may be the consequence of early negative experiences with math that go unchecked and lead to the negative math perception performance spiral. The human of Bandura (1989) in social cognition theory is useful for understand the potential personal, environmental and behavioral factors that may contribute to the development of math anxiety.

To understand the negative consequences of math anxiety, particularly reduced performance in math, examining math anxiety from a working memory model allows us to see how math anxious people might have reduced capacity in their working memory, thus resulting in worsened performance. While most work in the area of math anxiety has been conducted with adult and adolescent samples, several studies have shown that math anxiety is a separate construct in elementary school children (Gierl & Bisanz, 1995) and what personal factors such as self-concept and self-efficacy explain students’ levels of math anxiety (Jameson, 2008). It is apparent that math anxiety is a complex and multifaceted concept. The potential influences as well as potential outcomes of math anxiety are not easily understood, as there are many factors that could contribute to the development of math anxiety.

Mathematics anxiety is helplessness, panic, paralysis and mental disorganization that arise among some people when they are required to solve a mathematical problem. Math anxiety is a learned emotional response to one or more of the following: participating in a math class, listening to a math lecture and working through problems or discussing mathematics. Math anxiety is an intense emotional feeling of anxiety that people have about their ability to understand and doing mathematics. Some math anxious people have a fear of math called math phobia. People who have math phobia feel that they are incapable of doing activities that involve math. Math anxiety is an emotional rather than intellectual problem. However, math anxiety affects a person’s ability to learn math and therefore results in an intellectual problem. Mathematics anxiety can generate pressure to drive people to think or
react in an unreasonable way or cause avoidance of math classes until the last minute (Tobias, 1978).

Curtain-Phillips (2001) indicates that math is often associated with pain and frustration. For example, unforeseen debts, unpaid bills, unbalanced checkbooks and IRS forms are a few of the negative experiences associated with numbers.

In the test anxiety area, Liebert and Morris (1967) distinguished two components of test anxiety, worry and emotionality. **Worry** is the cognitive component of anxiety consisting of self-deprecatory thoughts about one's performance. **Emotionality** is the affective component of anxiety including feelings of tension, nervousness and unpleasant physiological reactions to testing situations. Both Liebert and Morris (1967) showed that these two components of anxiety are empirically distinct, though they are correlated and that worry relates more strongly than emotionality to poor test performance. Anxiety theorists (e.g., Sarason, 1986; Wine, 1971) believe that the worry or cognitive component of test anxiety interferes most with achievement performance.

Mathematics anxiety was first defined by Dreger and Aiken (1957) as emotional reactions syndrome displayed towards mathematics and arithmetic (Baloglu, 2001). Richardson and Suinn (1972) defined mathematics anxiety as involving “... feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations”.

Mathematics anxiety is an irrational and impeditive dread of mathematics (Lazarus, 1974). An irrational fear of mathematics that can range from a simple discomfort associated with numerical operations to a total avoidance of mathematics and mathematics classes (Mathison, 1977). Mathematics anxiety is defined as a tense and anxious feeling which may obstruct one from manipulating numbers and/or solving mathematical problems (Tobias, 1978). Mathematics anxiety is defined as a term “to describe the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem” (Tobias & Weissbrod, 1980). Mathematics anxiety is a panic state which keeps one’s thoughts under control (Buxton, 1981). Mathematics anxiety is not innate. People do not have mathematics anxious before going to school (Williams, 1988). Mathematics anxiety appears to be a “learned condition more behavioral than cognitive in nature” in a meta-analysis of 151 mathematics anxiety studies involving third grade through postsecondary students (Hembree, 1990).
Morris (1981) defined mathematics anxiety as a phenomenon which is one’s illogical fear that when one thinks of mathematics this fear causes one to freeze up, prevents one’s learning and performance, and causes distress. Mathematics anxiety is defined as feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations and can cause one to forget and lose one’s self-confidence (Tobias, 1993). Mathematics anxiety is “an emotion that blocks a person’s reasoning ability when confronted with a mathematical situation” (Spicer 2004, p. 1). Math anxiety is defined as a feeling of apprehension, tension or fear that interferes with math performance (Ashcraft, 2002). Mathematics anxiety is connected to both the affective and cognitive domains. The affective domain is connected to a state of emotion that is linked with fear and dread toward the future, and the cognitive domain is connected to the inability to perform certain math tasks (Furner & Duffy, 2002).

1.5 REVIEW OF RELATED LITERATURE

A literature review is an evaluative report of studies found in the literature related to researcher’s selected area. The literature review should give a theoretical basis for the research and help to determine the nature of research. A literature review goes beyond the search for information and includes the identification and articulation of relationships between the literature and researcher’s field of research. The form of the literature review may vary with different types of studies, but the basic purposes remain constant. For example, review of related literature provides a context for the research, justify the research, ensures that research has not been done before (or that it is not just a replication study), shows where the research fits into the existing body of knowledge, enables the researcher to learn from previous theory, illustrates how the subject has been studied previously, highlights flaws in previous research, outlines gaps in previous research, shows that the work is adding to the understanding and knowledge of the field and also helps to refine, refocus or even change the topic (Boote & Beile, 2005). The researches related to the variables under the following subheadings:

1.5.1 Studies Related to Computer Based Instruction
1.5.2 Studies Related to Achievement in Mathematics
1.5.3 Studies Related to Mathematics Self-Efficacy and Achievement
1.5.4 Studies Related to Mathematics Anxiety and Achievement
1.5.1 STUDIES RELATED TO COMPUTER BASED INSTRUCTION AND ACHIEVEMENT

Kulik, Kulik and Cohen (1980) studied the effectiveness of computer-based college teaching through meta-analysis of findings. This review used meta-analytic techniques of Glass (1976) to integrate findings from 59 independent evaluations of computer based college teaching. The meta-analysis of findings showed that computer based instruction made small but significant contributions to the course achievement of college students. It also produced positive and small effects on the attitudes of students toward instruction as well as toward their subject matter. It also found that computer assisted instruction reduced substantially the amount of time needed for instruction. The meta-analysis found little relationship between study findings and design features of the experiments and settings for the studies or manner.

Kulik, Bangert and Williams (1983) conducted a study on effects of computer-based teaching on secondary school students. They used quantitative techniques or meta-analysis to integrate findings from 51 independent evaluations of computer-based teaching in grades sixth to twelve. The analysis of findings showed that computer based teaching raised students’ scores on final examinations by 0.32 standard deviation or from the 50th to the 63rd percentile. Analysis also showed that computer based instruction had smaller but positive effects on scores on follow-up examinations given to students several months after the completion of instruction. Students who were taught on computers developed positive attitudes toward the computer and toward the courses they studying. The computer also reduced substantially the amount of time that students needed for learning.

Mevarech and Artzi (1987) studied on effects of computer assisted instruction with fixed and adaptive feedback on children’s mathematics anxiety and achievement. Participants were 245 sixth-grade students. Multivariate and univariate analyses of covariance showed significant differences between computer-assisted instruction and non-computer-assisted instruction treatments on various aspects of mathematics anxiety but not on mathematics achievement. No significant differences were found between the two computer-assisted instruction treatments on any variable.

Fuchs (1988) examined the effects of computer managed instruction on teachers’ implementation of systematic monitoring programs and student achievement. Subjects included 18 teachers who were assigned randomly to either a computer or non computer group and to either a goal-based or an experimental data evaluation method. Each teacher selected two mildly handicapped pupils for participation and implemented ongoing curriculum-based progress monitoring in accordance with their experimental treatments for
15 weeks. Achievement was measured at the beginning and end of the study and fidelity of treatment was assessed during the course of treatment. Multivariate analyses of variance indicated significant interactions. For the non computer group, performance was comparable within the two data utilization conditions. For the computer group, performance was superior within the goal-based evaluation condition. Pattern of results were similar on the student achievement and teacher fidelity measures.

Rieber (1990) examined the effects of animated presentations and practice in a computer based science lesson involving fourth and fifth grade students. Three levels of visual elaboration i.e. static graphics, animated graphics and no graphics were crossed with three levels of practice (behavioral, cognitive and no practice). Behavioral practice consisted of traditional questioning and cognitive practice consisted of a structural simulation. It was found that animated graphics were superior to static graphics and no graphics so long as practice was provided. Cognitive practice was generally superior to the other practice conditions and did not appear dependent on visual elaboration. Behavioral practice was effective only when paired with lessons containing animated graphics. The findings suggest that animated presentations can promote learning under certain conditions and they also demonstrate a successful application of interactive graphics in the design of cognitively based practice activities.

Kulik and Kulik (1991) in their meta analysis of findings from 254 controlled evaluation studies showed that computer based instruction usually produces positive effects on students. The studies included learners at all age levels from kindergarten pupils to adult students. Computer based instruction programs raised student examination scores by 0.30 standard deviation but significant effect. Effects were larger in published studies rather than unpublished studies and in studies in which different teachers taught experimental and control classes and in studies of short duration. Computer based instruction also produced small but positive changes in student attitudes toward teaching and computers. It also reduced substantially the amount of time needed for instruction.

Geban, Askar and Ozkan (1992) studied on effects of computer simulations and problem-solving approaches on students’ achievement in relation to science process skills and attitudes toward chemistry at the high school level. For this, two experimental groups were compared with the control group using the conventional approach. The sample consisted of 200 ninth grade students. The treatment for all groups was carried out over nine weeks. The results indicated that the computer simulated experiment approach and the
problem-solving approach produced significantly greater achievement in chemistry and science process skills than the conventional approach did.

Kulik (1994) presented evidence that using educational technology for drill and practice of basic skills could be highly effective.

Gwendolyn (1995) conducted a study on the use of computer-assisted instruction in non-conventional classroom environments in higher education. The purpose of this investigation was to determine the effectiveness of two instructional methods with borderline college level achievers. One method was conventional and the other was computer-assisted instruction. The experimental group was instructed using computer-assisted instruction and the control group was instructed by conventional method. The statistical technique used was the t-test for comparison of the means scores of both groups on five unit examinations with a 5% level of significance. Data were also collected by demographic survey. The results indicated that there was no significant difference between the achievement levels of the experimental and control group.

Stratham and Torell (1996) reviewed ten meta-analyses on the effectiveness of technology. Their findings indicated that (i) when computer technology properly implemented, it had a significant effect on student achievement as measured by test scores across subject areas and with students at all levels. (ii) when computer technology used appropriately, it increased teacher-student interaction and encouraged collaboration, cooperative learning, problem-solving, and student inquiry skills. (iii) Students from computer-rich classrooms demonstrated better behavior and had lower absentee and dropout rates than students from classrooms lacking computers. (iv) computer-based teaching was especially effective among populations of at-risk students.

Adam and Wild (1997) describe an investigation into the effect of CD-ROM storybooks on primary students' attitudes towards reading. To assess the degree of change in students' attitudes towards reading on exposure to CD-ROM storybooks, questionnaires in an experimental pretest-posttest design together with interviews of reluctant readers and unstructured observations of the treatment group were used. The results showed that no significant difference in children's attitudes existed between treatment and control groups after the treatment. Both groups demonstrated a similar development in their attitudes towards traditional reading materials.

Schacter and Fagnano (1999) presented findings from several meta-analyses indicating that computer-based instruction moderately improved student learning.
Choi-Koh (1999) studied a student’s learning of geometry using the computer. A secondary school student’s development of geometric thought during instruction was investigated using the P.M. Van Hiele (1986) model and dynamic computer software, the geometer’s sketchpad. During a twenty one hour study, the investigator used a clinical interview procedure to determine a student’s predominant level of thought and to gain an in-depth understanding of the development process of geometric reasoning. Ordered from simplest to most complicated, the four learning stages – intuitive, analytical, inductive and deductive learning were identified in terms of signal, symbol and implicatory properties. Results showed that the use of active visualization with dynamic software facilitated the movement from symbol to signal and then to implicatory character.

Mioduser, Tur-Kaspa and Leitner (2000) examined the unique contribution of computer based instruction when compared with more conventional modes of instruction (i.e. teacher instruction with textbooks) to early reading skills acquisition as well as the effects of specific features of computer technology on early reading skills performance. Forty six preschool children (aged 5–6) at high risk for learning disabilities participated in the study. They were assigned to three study groups that received different treatments. Three dependent variables such as children's word recognition, phonological awareness and letter recognition skills measured prior and after the treatment. Results indicated that children at high risk who received the reading intervention program with computer materials significantly improved their word recognition, phonological awareness and letter recognition skills relative to their peers who received a reading intervention program with only printed materials and those who received no formal reading intervention program.

Sivin-Kachala, Bialo and Rosso (2000) analyzed 219 recent research studies to assess the effect of computer technology on learning and achievement across all learning domains and all ages. In addition to positive effects on achievement in major subject areas, they found effective use of technology fostered the development of more positive student attitudes toward themselves and toward learning.

Thillaka and Pramilla (2000) investigated the use of computer multimedia programme in learning trigonometry among high school students. Experimental and quantitative method was adopted by the investigator. A total sample of 62 students studying in class 9th from Madras was taken for study. The probability sampling method was chosen for the study. Attitude scale was used for data collection. The findings of the study were (i) There is no influence of computer based multimedia programme on the achievement in mathematics
among high school students (ii) There is no significant change in the attitude of students towards mathematics after learning Trigonometry through computer based multimedia and text based self-study material (iii) There is no significant difference in achievement of mathematics between high achievers and low achievers for both experimental and control groups (iv) There is no significant difference in retention of learning in mathematics between experimental and control groups.

Yıldırım, Özden and Aksu (2001) investigated the comparison of hypermedia learning and traditional instruction on knowledge acquisition and retention. A comparison was made between hypermedia learning environments and traditional instruction in terms of contribution to procedural, declarative and conditional knowledge acquisition and retention in a specific subject area through a pre-test post-test control group design. Thirty nine biology students of 9th grade to experimental i.e. hypermedia learning environment and control i.e. traditional instruction groups were assigned through a matched –pair technique. Both groups were given pre-test, post-test and retention tests. Post test results indicated no significant difference between control and experimental groups in acquisition of procedural, declarative and conditional knowledge. But retention test results showed that experimental group retained all three types of knowledge significantly better than did the control group.

Skinner (2002) demonstrated the effects of computer based instruction on the achievement of college students as a function of achievement status and mode of computer based instruction i.e. computer based instruction tutorials optional or mandatory in the context of a course taught under a Personalized Systems of Instruction format. A unique aspect of the study was the use of a single subject (alternating treatments) research design involving frequent measures of performance over time and visual inspection of data. Results indicated that low achieving students benefited more from computer based instruction than did high achievers.

Thomas and Emereole (2002) investigated the effects of a computer based instruction in teaching physics. The purpose was to determine how effective the computer based instruction or the use of computer as an instructional technology would be in enhancing academic achievement and attitude towards the classroom integration of computer technology. An experimental design was used. The experimental group was taught certain topics from electricity and basic electronics using computer based instruction and traditional instructional methods while the control group was taught the same content by the same
teacher using traditional instruction only. An analysis of covariance revealed significantly higher performance for the experimental group than control group.

Moreno and Mayer (2002) studied on learning science in virtual reality multimedia environments in relation to role of methods and media. For this study, college students learned about botany through an agent-based multimedia environment. In experiment 1, students got either spoken or identical on-screen text explanations. The lesson was presented either through a desktop display, a head-mounted display used while sitting or a head-mounted display used while walking. In experiment 2, they examined the effects of presenting explanations as narration, text, or both within the display and walking conditions. Students scored higher on transfer, retention and program ratings in narration conditions than in text conditions. The narration text conditions produced results in between students gave higher ratings of presence when learning with head-mounted displays but media did not affect performance on measures of transfer, retention or program ratings.

Chang (2002) conducted a study on effectiveness of computer assisted instruction in relation to problem solving and science outcomes. The effectiveness of a problem solving based computer assisted instruction and a lecture internet discussion instruction were compared for Taiwan senior high school students' science achievement and attitudes towards science. A pre-test post-test control group experimental design involving eight classes was used. Experimental group students (n=156) received the problem solving based computer assisted instruction and control group students (n=138) received the lecture internet discussion instruction. The tools of earth science achievement test and the attitude toward earth science inventory was used. A multivariate analysis of covariance suggested that (a) Students taught using the problem solving based computer assisted instruction scored higher but not significantly higher than did students in lecture internet discussion instruction group (b) There were statistically significant differences in favor of the problem solving based computer assisted instruction on student attitudes toward the subject matter.

Pravinchandra (2003) studied on effectiveness of computer assisted learning strategy for teaching English grammar. Forty trainee teachers doing B.Ed. in Braruch district were chosen purposively. Experimental group was taught by computer assisted learning strategy for two weeks in the computer lab of the institution. The control was taught for same amount of time through conventional teaching method. The study indicates that computer assisted learning strategy has immense potentiality to bring positive change in teaching learning process. The study explores its effectiveness in terms of achievement.
Malliga (2003) studied relative effectiveness among different strategies of computer mediated multimedia presentation in teaching and learning of chemistry at higher secondary stage. Quasi experimental method, qualitative and quantitative approaches were adopted by the author for the study. A sample of 108 girl students from matriculation and higher secondary school, Erode district in Tamil Nadu was taken with the help of probability sampling technique. The t-test and analysis of variance were used for data analysis in the study. He found that (i) Interactive individualising learning supported by multimedia presentation was found to be the most effective strategy among all the three different instructional strategies i.e. peer based learning, individualized learning supported by multimedia presentation, interactive individualized learning supported by multimedia presentation in terms of cognitive skills such as knowledge, comprehension and application in realising the instructional objectives in Chemistry at ninth class (ii) Peer based learning was found to be coming between individualized learning supported by multimedia presentation and interactive individualized learning supported by multimedia presentation in enhancing the retention of what have already been learnt (iii) It was inferred that interactive individualized learning supported by multimedia presentation was more effective one while individualized learning supported by multimedia presentation was the least effective one (iv) It was found that while the subjects of all the three experimental groups were identical in terms of scientific attitude and non identical in terms of their computer attitude (v) The results of the study indicated that the enhancement of learning Chemistry was only due to the media effectiveness.

Ysseldyke, Spicuzza, Kosciolek and Boys (2003) investigated effect of a learning information system on mathematics achievement and class room structure. The authors examined the effects of implementing an instructional system that automates application of evidence – based components of effective instruction on student mathematics achievement and on classroom behaviors known to be related to overall student achievement outcomes. A treatment group of one hundred fifty seven 4th and 5th grade students used the intervention in conjunction with the everyday mathematics curriculum. Student performance was compared with the everyday mathematics curriculum. Student performance was compared with a with in-school conjunction group of sixty one 4th and 5th grade students, as well as all the 4th and 5th grade students in the district (n=6385). The students in control group received only the everyday mathematics curriculum. Results indicated that implementation of the instructional management system as an enhancement to everyday mathematics resulted in an increase in
the amount of time spent on classroom activities that researchers have identified as contributing to positive academic outcomes. Also, students who used the accelerated mathematics program demonstrated greater mathematics achievement gains than did the control groups.

Choi-Koh (2003) studied the effect of a graphing calculator on a 10th grade students’ study of trigonometry. The author investigated the patterns of one student’s mathematical thinking processes and described the nature of learning experience that the student encountered in trigonometry as author engaged in independent explorations within an interactive technology environment. A 10th grade student who attended a college preparatory high school in the suburb of Seoul, Korea was participated in the study. The results showed that the student moved hierarchically from an intuitive stage to an operative stage and then to an applicative stage of thinking.

Tabbers, Martens and Van-Merrienboer (2004) studied the multimedia instructions and cognitive load theory in relation to effects of modality and cueing. A sample of 111 second year students from department of Education at the University of Gent in Belgium was taken for the study. Only a weak cuing effect and even a reverse modality effect have been found which indicates that both effects do not easily generalize to non-laboratory settings. The authors gave a possible explanation for the reversed modality effect is that the multimedia instructions in this study were learner paced as opposed to the system paced instructions used in earlier research.

Carter (2004) analyzed the effect of computer assisted instruction on students’ attitude and achievement in a college remedial mathematics course. The statistical analysis of data compiled in this study includes the use of paired and independent group tests, analysis of covariance tests. The paired tests result showed that there was a statistically significant achievement gain with treatment and control groups as a result of instruction on that each group received. However, analysis of covariance revealed that there was no statistically significant difference in achievement gains between the two groups when the study ended. All the tests showed no significant change in attitude between the two groups.

Senteni (2004) found out that computer based instruction increases the motivation level and achievements of the students. It also develops positive attitudes among students.

Basturk (2005) investigated on the effectiveness of computer assisted instruction in teaching introductory statistics. A quasi-experimental design compared learning outcomes of participants in an introductory statistics course that integrated computer assisted instruction to
participants in a lecture only introductory statistics course. The results showed that participants in lecture plus computer assisted instruction section obtained higher averages on midterm and final exams than participants in the lecture only sections and these higher averages likely were because of their better performance on concepts and practices that were taught in both regular lecture and computer assisted instruction course. However, when the topics of the introductory statistics course moved from descriptive statistics to inferential statistics, then the learning gap between lecture only and lecture plus computer assisted instruction is also increased. Findings suggest that participants’ learning capacity of the introductory statistics could be improved successfully when computer assisted instruction used as a supplement to regular lecture in teaching introductory statistics course.

Barot (2005) conducted a study to develop computer assisted instruction in Sanskrit for 8th standard students and to study its effectiveness in terms of mean achievement of students in Sanskrit and to study the reactions of the standard 8th students regarding the effectiveness of the developed computer assisted instruction package. Eighty six students of Standard 8th of Shree Ambe Vidyalaya, Waghodia Road, Baroda constituted the sample for the study. A single group pre-test and post-test design was employed for the study. Achievement test and reaction scale was constructed by the investigator. Flash MX, Corel Draw 11 and Front Page were used for the development of software. The t-value, frequencies and percentages responses were used for data analysis. The developed computer assisted instruction in Sanskrit was found effective in teaching Sanskrit to 8th standard students. The reactions of the students towards the developed computer assisted instruction in Sanskrit were found positive.

Wighting (2006) conducted a study on effects of computer use on high school students’ sense of community. The author used a mixed method design to determine whether and how use of computers in the classroom affects sense of learning in a community among high school students (N=181). The results indicate that using computers in the classroom positively affects students’ sense of learning in a community. According to the analysis of data, students believed that connectedness with their peers are the most important variable in developing a sense of community. Results also suggest the following policy implications for urban education (a) use of computers in teaching may add to the sense of classroom community and (b) sense of community is important and may be linked to academic success.

Liao (2007) compared fifty two research studies carried out in Taiwan in his meta analysis study and found that computer based instruction had a positive effect on individuals.
Bayrak (2008) in a study investigated whether computer assisted instruction was more effective than face to face instruction in increasing student achievement in Physics. The study was conducted at the department of science and mathematics for secondary education at Hacettepe University. Seventy eight freshman students from divisions of biology education and chemistry participated in the quantitative study which includes a pre-test post-test control group design. The experimental group comprised of students from division of biology education while control group consisted of students from division of chemistry education. Experimental and control groups were randomly selected for the study. The subject of geometric optic covered in physics II course was provided through a simulation programme called Pearls 3.0 to the experimental group, whereas the control group had the same instruction through face to face teaching methods. An achievement test based on geometric optic subject was prepared having an internal consistency coefficient of 0.73. Data obtained through the achievement test were analyzed through conducting t-tests with statistical package for social sciences 11.0 for windows. Findings revealed that the experimental group which had the instruction through computer simulation was more successful than the control group.

Kanmani and Radha (2009) studied on effectiveness of computer assisted instruction package in basic electronics teaching and found that there is significant difference between the control and the experimental group students in the attainment of application level objectives in the gain scores.

Nimavathi and Gnanadevan (2009) studied on impact of multimedia programme in teaching science for the development of study habits. A sample of IXth standard students were taken for the study. Pre-test and post-test equivalent group design was used. The students of experimental group fared better in their achievement than the students of control group after experimentation. This shows that the multimedia increases the achievement of the students.

Moos and Azevedo (2009) investigated learning with computer based learning environments: A literature review of computer self-efficacy. Although computer based learning environments are becoming more prevalent in the classroom, but this empirical research has demonstrated that some students have difficulty in learning with these environments. Computer self-efficacy plays an integral role in learning with computer based learning environments. Results indicate that behavioral and psychological factors are positively related to computer self-efficacy. Students who received the behavioral modeling
report significantly higher computer self-efficacy than do students who receive the more traditional instruction based method. Computer self efficacy is related both to learning outcomes and to learning processes with computer based learning environments.

Spradlin (2009) investigated the effectiveness of computer assisted instruction in developmental mathematics. Colleges and universities are trying alternative instructional approaches to improve the teaching of developmental mathematics with the goal of increasing the number of students who have the skills and knowledge required for college-level math courses and for the twenty-first century workforce. Computers make possible new methods of delivering instruction so students will have choices of when, where and how they learn math. The main purpose of this study was to compare academic performance of students enrolled in a developmental mathematics course. The three teaching strategies i.e. traditional instruction, traditional instruction supplemented with computer assisted instruction and online distance learning were used for the study. In addition, gender differences in mathematical performance were also investigated. It was quasi-experimental study conducted in Intermediate Algebra classes at a large private Eastern University. ANOVA was used to adjust the mean post-test scores for any initial difference in the groups on the pre-test. The results showed that there was no statistically significant difference in the post-test scores of students receiving traditional instruction and traditional instruction supplemented with computer assisted instruction. But there was a significant difference in the post-test scores of males and females, with females outperforming males in both modes of instruction.

Philip, Jackson and Dave (2011) studied on the effect of computer assisted instruction on student’s attitudes and achievement in matrices and transformations in secondary schools in Uasin Gishu district, Kenya. Research indicated that computer assisted instruction enhances students’ achievement, promotes positive attitudes towards mathematics and instruction and improves interpersonal relations. The main purpose of this study was to investigate the effects of computer assisted instruction on students’ attitude and achievement in matrices and transformations between students who received instruction using computer assisted instruction module or conventional instruction methods. The pre-test post-test control group experimental research design was used in the study. Two hundred five students were participated in the study. Results of this study indicated that computer assisted instruction resulted in higher achievement and positive attitudes among students. Hence, computer assisted instruction offers a valuable means for improving mathematical knowledge, skills and performance in mathematics.
Serin (2011) investigated the effects of the computer based instruction on the achievements and problem solving skills of the science and technology students. The pre-test post-test control group design was used in this study. There were fifty two participants in the study having twenty six each in the experimental group and control group. The achievements test and the problem solving inventory for children were used to collect data. The experimental group was exposed to computer based science and technology instruction three hours a week during three weeks. For the analysis of data, t-test, Kolmogorov-Smirnov single sample test and covariance were used. The result of the study reveals that there is a statistically significant increase in the achievements and problem solving skills of the students in the experimental group that received the computer based science and technology instruction.

Sama (2011) conducted a study on effect of multimedia presentation and CAI package on achievement in physics in relation to learning styles and gender. Experimental design 2×4×3 pre-test, post-test control group design was employed. The population of study comprised of 9th class students studying in secondary schools situated in Chandigarh and Mohali. Purposive sampling technique was resorted for selection of three schools. Only those schools where medium of instruction was English, computer facilities were available and were willing to participate in the study were chosen. Descriptive statistics like mean, median, mode, S.D., skewness and kurtosis were computed to study nature of distribution of data. 2×4×3 analysis of variance, F-ratios and t-ratios were computed to find out significance of difference between means of gain achievement scores. She found that students taught through multimedia presentations showed significantly higher mean gain achievement scores than students taught through CAI package. Students taught through CAI package achieved significantly higher mean gain achievement scores than students taught through conventional mode of teaching.

Aggarwal (2012) conducted a study on effectiveness of computer based concept mapping in acquisition of concepts of chemistry in relation to attitude towards science. 240 students were randomly drawn from 9th science students studying in Punjab School Education Board affiliated schools in Amritsar. A 2×2×2 factorial design and descriptive statistics was used. She found that students taught through computer based concept mapping were found to have achieved significantly high in acquisition of concept of chemistry than those students who were taught through lecture method.
Guven (2012) examined the effect of dynamic geometry software on students' learning of transformation geometry. The quasi-experimental design with pre and post-test was used. Sixty eight participants in the study of eighth grade (36 in the experimental group and 32 in the control group) were selected for the study. The experimental group was studying the transformation geometry in a dynamic geometry environment; the same instruction was carried out with dotted and isometric worksheets with the control group students. A fifteen multiple choices in transformation geometry achievement test and a fifteen open ended items in learning levels of transformation geometry test were used as pre-test and posttest. The results of analysis showed that the experimental group outperformed the control group not only in academic achievement but also in levels of learning of transformation geometry.

Driver (2012) studied the impact on student achievement of when computer algebra system technology is introduced. When a computer algebra system technology is used as a pedagogical and functional tool in class and in exams, then its effect on student achievement can be found. The timing of when students are first introduced to a computer algebra system technology has an impact on gains in student achievement. The computer algebra system calculator was introduced to students and used to varying degrees in years ten, eleven and twelve. The effects on students' final year results were examined in terms of the timing of the introduction of the computer algebra system device and the extent of its use in the classroom. And it was found that there is some evidence of greater improvement in learning by introducing the calculator in year ten rather than year eleven. This gain is clear for low, average and above average mathematics achievers.

Ramani and Patadia (2012) investigated the effectiveness of computer assisted instruction in teaching arithmetic. This true experimental study compared academic performance of students in class 8th in one of the English Medium school of Vadodara, India with respect to three teaching strategies such as traditional instruction, only computer assisted instruction and computer assisted instruction with simultaneous discussion. The post-test control group design was used in the study. Three sections of class 8th students were selected and groups were randomly allotted. ANCOVA was used in data analysis. The results showed that there was significant difference in the post-test scores of students receiving instructions through traditional method, only computer assisted instruction and computer assisted instruction with simultaneous discussion. It revealed that traditional method is as effective as only computer assisted instruction. Computer assisted instruction with simultaneous
• **Review of Researches**


1.5.2 STUDIES RELATED TO ACHIEVEMENT IN MATHEMATICS

Peterson, Swing, Braverman and Buss (1982) found that students’ reported understanding on mathematics lesson content and use of specific cognitive strategies were significantly related to achievement.

Hamilton (1995) found computer assisted instruction resulted in significant achievement differences for elementary and secondary students crossing all ability levels in mathematics.

Helwig, Rozek-Tedesco, Tindal, Heath and Almond (1999) investigated reading as an access to mathematics problem solving on multiple choice tests for sixth grade students. The effect of providing middle school students with a video accommodation for a standardized mathematics test was examined. A total sample of two hundred forty seven students was
Introduction

asked to solve 60 word problems. One half of questions were presented in standard form while the other half were read with video accommodation. The grouping of students was done on the basis of their mathematics and reading ability. The problems were identified as having relatively high reading difficulty according to number of verbs, word familiarity and word count. The results showed that students with above average mathematics proficiency but low reading skill performed better when questions were presented in video format.

Soe, Koki and Chang (2000) investigated the effect of computer assisted instruction on reading achievement. This meta-analysis reviewed 17 research studies based on K–12 students and revealed that computer assisted instruction does have a positive effect on reading achievement. Findings of the meta analysis suggest that computer applications to teach reading hold great promise as instructional tools.

Barbato (2000) reported that the class of 10th grade, taught cooperatively had significant higher mathematics achievement than traditional group.

Brown (2000) investigated that computer assisted instruction in mathematics can improve students’ test scores. This research assessed the academic impact of a computer assisted instructional software program to teach mathematics. The study comprised of elementary and middle grade students from a large urban North Carolina public school system with an enrollment of 100,000 approximately. The study divided the students into two groups (a) experimental group that used the computer assisted instruction program (b) a control group of students who were not exposed to the computer assisted instruction program. The finding showed that students benefit from the use of a computer assisted instruction software program as a supplement to regular classroom instruction in basic mathematics and algebra.

Hannafin, Burruss and Little (2001) studied on learning with dynamic geometry programs: Perspectives of teachers and learners. In this exploratory phenomenological study, the authors examined teacher and student roles in and reactions to a student centered instructional geometry program using the geometer’s sketchpad. The 7th grade students worked for two weeks in their regularly scheduled mathematics class on activities that allowed them to explain on screen relationships among geometric shapes. The class sessions and specific dyads were observed. Teacher and selected students were interviewed. Findings centered on two overarching themes such as issues of power and learning. The teacher had difficulty to control the learning environment even though she had agreed to do so. Students worked hard, liked their new freedom and expressed greater interest in the subject material.
Singh, Granville and Dika (2002) explored the effects of motivation, attitude and academic engagement on mathematics and science achievement. The purpose of the study was to examine the effects of three school related constructs – motivation, attitude and academic engagement on students’ achievement in mathematics and science. The authors used the sample of 8th graders drawn from the national education longitudinal study 1988. Structural equation models were used to estimate and test the hypothesized relationships of two motivation factors i.e. attitude factor and academic engagement factor on achievement in mathematics and science. Results suggest the positive effects of the two motivation factors, attitude and academic engagement on mathematics and science achievement.

Hay (2003) conducted a study on computer assisted instruction in mathematics in determining the volume of three dimensional figures. This study was a field test of computer assisted instruction in geometry. The subjects were eighth grade general math students from a heterogeneous group from Palos Verde’s intermediate school. The purpose of this computer assisted instruction was to teach an in-depth, unique lesson of finding the volume of three dimensional figures. The pre and post test evaluation provided the assessment tool and results indicated that computer assisted instruction tutorial was valuable in helping students learn how to determine volume of three dimensional figures.

Bump (2004) studied the effect of computer based multimedia, interactive mathematics programme on the mathematics achievement of developmental mathematics college students. The results indicated that there is a statistically significant difference between the mathematics achievement of students who participated in a computer multimedia interactive mathematics programme and the mathematics achievement of students who did not participate in a computer multimedia interactive mathematics programme.

Mehra and Rathee (2004) compared the effect of different instructional strategies viz. inquiry training model, mastery learning model and traditional instruction on achievement and retention in mathematics on the sample of one hundred eight class 5th students. The findings of the study were (i) Students taught through inquiry training model and mastery learning model yielded comparable mean gain on achievement scores and retention scores as compared to those through traditional instruction (ii) Field independent students yielded better mean gain on achievement scores and retention scores as compared to their field dependent counterparts (iii) Comparable mean gain on achievement scores was yielded by the students at knowledge and comprehension, category of objectives but they exhibited more retention scores at knowledge category than at comprehension category.
Ash (2005) studied the effects of computer assisted instruction on middle school mathematics achievement. A quasi-experimental study was used. Pre-test post-test design was adopted by the author. The control group was taught by traditionally teaching methods. The experimental group received the same traditional teaching methods plus one hour a week of computer assisted instruction. These computer assisted instructions were in the form of Orchard software. The scores of the post-test and pre-test were calculated and the means of the differences from the experimental group and the control group were compared using t-test. The results of the data analysis indicated that the use of computer assisted instruction in addition to traditional teaching methods is more effective than traditional teaching methods alone.

Kurz, Middleton and Yanik (2005) studied on taxonomy of software for mathematics instruction. The use of mathematics software is to enhance student thinking. Author discussed that there are five categories of tool based mathematics software that can be used fruitfully in a mathematics curriculum (a) review and practice (b) general (c) specific (d) environment and (e) communication. These can be used to achieve the goals of mathematics instruction from basic skills to exploring mathematical applications in the real world.

Kaur (2006) studied the effect of CAI video assisted instruction and self learning modules on achievement in mathematics in relation to cognitive styles. The investigator had drawn a randomly sample of one hundred fifty three students of class tenth from four Govt. High schools of Chandigarh. A 3x2x2 factorial design was used by the investigator. She found that CAI and Video assisted instruction results better than self learning modules.

Olaoye and Akinsola (2007) studied on learners’ skills improvement of inverse squared matrix in mathematics using computerized instruction. The study centred on learners’ skill improvement of inverse squared matrix in mathematics through three instructional methods which comprised of conventional, computerized formula and combination instructional modes. Students were randomly selected into each group that contained forty students each. Two research questions and hypotheses were raised and tested at a significant level of 0.05. Instruments used were developed questionnaires on students’ attitudes towards mathematics (r=0.65) and adapted one on computer (r=0.69) and the computerized formula instructional mode. Data were analyzed through the use of descriptive statistics like mean, standard deviation, t-test, one-way analysis of variance and Scheffe test. However, findings revealed that students that were exposed to the combination instruction mode performed better than other two groups whose performances were at variance.
Singh (2010) conducted a study on effectiveness of computer assisted instruction in acquisition of mathematical concepts in relation to achievement motivation and study habits. The investigator selected three C.B.S.E. schools from Jagraon in district Ludhiana. A 2×2×2 factorial design was employed to see the interaction effect. For significant F-ratio, t-test was employed so as to find out significance of difference between mean related to different groups and different variables. He found that students taught through computer assisted instruction yielded better gain on acquisition of mathematical concepts as compared to those taught through traditional teaching method.

Iyekekpolar (2011) studied the computer assisted instruction on students’ achievement in mathematics. A stratified random sample of eighty students made up equal number of boys and girls were selected. They divided into two groups i.e. the experimental and control group each comprising of 20 boys and 20 girls. Both the two groups were taught mathematics for 10 weeks. The experimental group was taught by computer assisted instruction while control group by conventional mode of instruction. Both pre-test and post-test were administered to both the groups before and after the experiment to determine difference in achievement between the groups. Data was analyzed using means, simple percentages and t-test. The findings showed that (i) Computer assisted instruction produced higher mathematics achievement in students than the conventional instructor (ii) With computer assisted instruction, boys performed better.

Bayturan and Kesn (2012) studied the effect of computer assisted instruction on the achievement and attitude towards mathematics of students in secondary mathematics education. The experimental pre-test post-test design was used. The research was conducted on sixty students of 9th grade from an Anatolian high school. Each experiment group and control group consisted of 30 students. Computer assisted teaching material was developed by Flash MX program related with the unit of “Relation, Function and Operation” of the area of learning algebra and took 10 weeks. The experimental group was taught by computer assisted instruction and control group was taught by traditional instruction methods. The data were collected by using the mathematics test and mathematics attitudes scale. The results demonstrated that teaching mathematics with a computer assisted instruction method increased student success significantly in mathematics lesson.
• **Review of Researches**

Many studies have been conducted to find out the achievement of students in mathematics whether they are provided with computer based instruction or any other teaching strategy except traditional mode of teaching method. The findings were supported by the studies of Peterson, Swing, Braverman and Buss (1982), Hamilton (1995), Helwig, Rozik-Tedesco, Tindal, Heath and Almond (1999), Soe, Koki and Chang (2000), Barbato (2000), Brown (2000), Hannahin, Burruss and Little (2001), Singh, Granville and Dika (2002), Hay (2003), Bump (2004), Mehra and Rathee (2004), Ash (2005), Kurz, Middleton and Yanik (2005), Kaur (2006), Olaoye and Akinsola (2007), Singh (2010), Iyekekpolar (2011), Bayturan and Kesan (2012) which showed that students achieve significantly high scores in mathematics when they are provided with any teaching strategy except traditional mode of teaching method.

1.5.3 **STUDIES RELATED TO MATHEMATICS SELF-EFFICACY**

Hackett and Betz (1989) studied an exploration of the mathematics self-efficacy/mathematics performance correspondence. They authors investigated the relationship among mathematical performance, mathematics self-efficacy and attitudes towards mathematics and the choice of mathematics related majors by 153 college women and 109 college men enrolled in introductory psychology courses at a large Midwestern University. Hacket and Betz reported that mathematics performance was correlated moderately with mathematics self-efficacy. Similarly, both mathematics performance and mathematics self-efficacy significantly and positively correlated with attitudes towards mathematics and mathematics related majors.

Stage and Kloosterman (1991) found a correlation between seventh grade students’ beliefs about how mathematics is learned and their achievement in mathematics.

Lopez and Lent (1992) found that math self-efficacy correlated significantly and positively with course grades. This study found evidence for those high school students or their math self-efficacy beliefs largely from prior experiences and form emotional arousal information. Consequently, poor performance and lack of self-efficacy towards mathematics result in a lack of motivation to enroll in future mathematics courses.

Lent, Lopez and Bieschke (1993) examined undergraduate college students’ mathematics self-efficacy as related to achievement, interest, grades and enrollment intentions. Mathematics self-efficacy and achievement predicted mathematics grades while
Introduction

mathematics self-efficacy and outcome expectations predicted interest and enrollment intentions.

Randhawa, Beamer and Lundberg (1993) found that generalized math self-efficacy mediated the effect of various math attitudes on math achievement. However, their generalized math self-efficacy was the composite score of the three subscales of the Mathematics Self-Efficacy Scale (MSES)—judgments of capability to solve math problems, complete math-related tasks, and succeed in math-related courses. The criteria task was a mixture of the composite of teacher-assigned grades in algebra and scores on an algebra achievement test. The achievement test portion of the outcome measure was conceptually related only to the problems scale, although problems on the test differed markedly from those presented on the self-efficacy assessment; the teacher-assigned grades bore little relation to any of the self-efficacy judgments. Consequently, although the math attitude measures had a strong direct effect on self-efficacy, they also had a stronger direct effect on performance than did self-efficacy.

Pajares and Miller (1994) conducted a path analysis to test the predictive and mediational role of self-efficacy beliefs in mathematical problem solving. The study was conducted with 350 undergraduates including 229 women and 121 men at a large Southern University. One hundred thirty seven were education majors while 213 represented a variety of majors. The authors utilized six different instruments to test six different parameters: mathematics self-efficacy, perceived usefulness of mathematics, mathematics anxiety, math self-concept, prior experience and math performance. The findings showed that math self-efficacy was more predictive of problem solving than perceived usefulness of mathematics, math self-concept and prior mathematics experience or gender. The resultant path analysis showed that self-efficacy was an antecedent to the learning experience.

Pajares and Miller (1995) found that students' reported confidence to answer math problems was a greater predictor of performance than their math-related tasks or math-related courses self-efficacy. They asked 391 students to provide three types of mathematics self-efficacy judgments. Students were reported confident to answer the problems they were later asked to solve proved a more powerful predictor of that performance than either their confidence to perform math related tasks or to succeed in math related course.

Pajares and Kranzler (1995) used path analysis to test the influence of math self-efficacy and general mental ability on math solving performance of high school students. Ability and self-efficacy had strong direct effects on performance. Ability had a strong direct
effect on self-efficacy which largely mediated the indirect effect of ability and background on performance while self-efficacy had a strong direct effect on anxiety which in turn had a weak direct effect on performance.

Van-Akkeren (1995) investigated the effect of cognitive modeling of Polya’s four-phase approach to problem solving on fourth grader’s performance and self-efficacy for process problem solving in mathematics. The impact of cognitive modeling was compared to effect of exemplar modeling and a control group that received guided practice. Eighty four students from one suburban elementary school were randomly assigned to two modeling groups and a control group. For problem solving performance, post test results showed that both modeling groups out performed the control group. Findings were statistically significant at the 0.05 level. When compared to control group, an effect size of 1.26 was found for cognitive modeling and 1.34 for exemplar modeling. Cognitive modeling did not prove to be more effective than exemplar modeling. Similar results were found for the two week follow up. For self-efficacy, post test results showed no statistically significant differences among the groups. When compared to the control group, small effect sizes were generated in favor of the modeling groups. Similar findings were found for the two week follow up.

Lent, Lopez, Brown and Gore (1996) conducted two studies testing four and five factor models of self-efficacy among either high school or college mathematics students. One study involved factor analysis of responses from 295 college students using a four factor structure such as performance, social persuasion, vicarious learning and emotional arousal and the other study analyzed responses from 481 students in a five factor structure such as performance, peer modeling, adult modeling, social persuasion and emotional arousal. The four factor model fit best for college students and the five factor model fit best for high school students indicating that, apparently because of age and maturity differences, high school students may react differently to adult and peer modeling, whereas the age of the model seems less important among college students. Theoretically the confirmatory factor analysis fit indices supported discrete factors but practically there existed a strong inter-correlation among personal performance, social persuasion and emotional arousal. Vicarious learning did not fit as well as the other three factors which indicate that watching others succeed mathematically may or may not affect an individual’s self-efficacy toward mathematics.
Kennedy (1996) in his study reported that science self-efficacy did not significantly influence academic achievement. It is thought achievement might be indirectly affected a combination of self-efficacies for science, mathematics and self-regulated learning.

Pajares and Valiante (1997) conducted a study on influence of self-efficacy on elementary students’ writing. A total sample of 218 students from 5th grade classroom was taken and found that aptitude had a strong direct effect on self-efficacy which mediated the indirect effect of aptitude on performance. Further, it was found that self-efficacy also had direct effects on apprehension and perceived usefulness.

Malpass, O’Neil and Hocevar (1999) found that self-efficacy was very negatively related to worry, positively related to math achievement and self-regulation and played a mediating role between prior and subsequent mathematics achievement.

Brien, Martinez-Pons and Kopala (1999) studied on ethnic identity, mathematics self-efficacy, career interests and gender related to mathematics and science. Four hundred fifteen parochial school students of 11th grade were surveyed to assess their ethnic identity, mathematics self-efficacy and career interests in mathematics and science. Path analysis disclosed a direct effect of gender on students' career interest. In addition, career interest was predicted by mathematics self-efficacy and self-efficacy was, in turn, influenced by ethnic identity, academic achievement and socio-economic status.

Wolters and Rosenthal (2000) investigated that students with higher levels of self-efficacy set higher goals, apply more effort, persist longer in the face of difficulty and are more likely to use self-regulated learning strategies.

Husch (2001) investigated the relationship between personality temperaments, mathematics self-efficacy, learning styles and postsecondary calculus achievement. The data included ACT mathematics scores, Myers-Briggs personality types, mathematics self-efficacy scores and calculus test scores of sample of the University of Tennessee at Knoxville College students enrolled in the first and second semester calculus classes which utilized web based materials. Findings were significant for several dimension of learning style and temperament with respect to both the calculus test and the math self-efficacy instruments. The students who were categorized as SPS on the Myers-Briggs type indicator scored significantly lower on the calculus test and the mathematics self-efficacy scale.

Pietsch, Walker and Chapman (2003) investigated the relationships between self-efficacy and performance in mathematics among four hundred sixteen high school students, and self-efficacy beliefs were identified as most highly correlated with performance.
Nicolaidou and Philippou (2003) investigated the relationships between self-efficacy beliefs in problem solving, students’ attitudes towards mathematics, and achievement. Attitude and efficacy scales were completed by two hundred thirty eight pupils of fifth grade. Problem solving performance was measured by test including simple as well as multi step questions. The analysis of the data indicated significant relationship between attitudes and achievement and a stronger relationship between efficacy and achievement. Furthermore, attitudes and self-efficacy were also correlated and both predicted achievement in problem solving. However, self-efficacy was a more powerful predictor than attitudes.

Stevens, Olivarez, Lan and Tallent-Runnels (2004) conducted a study on role of mathematics self-efficacy and motivation in mathematics performance across ethnicity. The author evaluated self-efficacy and motivational orientation across Hispanic and Caucasian students to predict variables related to mathematics achievement including mathematics performance and students' plans to take additional mathematics courses. Path models were analyzed for three hundred fifty eight students in grades 9 and 10 who attended a West Texas high school and for the sample split by ethnicity. Tests of each model parameter across ethnicity revealed one significant difference suggesting that the relationship between prior mathematics achievement and self-efficacy was stronger for Hispanic students. Findings indicated that similar motivational systems exist to predict mathematics achievement across ethnicity. It was also found that Caucasian students do not place as much emphasis on prior mastery experiences as do Hispanic students suggesting that other factors are active in influencing their self-efficacy.

Shores and Shannon (2007) investigated the relationships between motivation, anxiety, self-regulated learning, attributions and achievement in mathematics. In this quantitative study, a total sample of 761 students from fifth and sixth grade mathematics classrooms in Alabama was surveyed. Data analysis revealed that significant contributions are made by motivation and anxiety on both test score and mathematics grade for fifth grade students. Specific factors such as self-efficacy, worry and failure were related to academic performance while failure attribution was significantly related to mathematics grade. As for sixth grade students, data analysis showed that relationships exist among motivation; anxiety and academic performance with specific factors such as intrinsic value, self-efficacy and worry significantly predicting both test score and mathematics grade for sixth graders.

Spence and Usher (2007) found mathematics self-efficacy to be among the most significant predictors of mathematics achievement. They also found that computer self
Introduction
efficacy and computer playfulness were associated with courseware engagement and that self-regulation was an important component of e-learning.

Hoffman and Spatariu (2008) examined the influence of self-efficacy and meta-cognitive prompting on math problem solving efficiency. Firstly, students completed a math background inventory then assessed their self-efficacy. They were assigned to a prompting group or a control group with no prompting. They found that self-efficacy and meta-cognitive prompting increased problem solving performance and efficiency separately through activation of reflection and strategy knowledge, supporting their motivational efficiency hypothesis.

Akin (2008) investigated relationship between self-efficacy, achievement goals, depression, anxiety and stress. Participants were six hundred forty six university students who completed a questionnaire package that included self-efficacy scale, 2×2 Achievement Goal Orientation Scale and Depression Anxiety Stress Scale. The structural equation modeling supported the hypothesis model and all proposed paths were significant. Results suggest that learning-approach goals were predicted positively and learning-avoidance, performance-approach/avoidance goals, depression, anxiety and stress negatively by self-efficacy. Also depression, anxiety, and stress are indirectly and negatively predicted by self-efficacy through the achievement goals. But learning-approach goals predicted depression, anxiety and stress negatively and other achievement goals predicted positively.

Hodges (2008) found a statistically significant relationship between self-efficacy to learn mathematics asynchronously and achievement. Measurements within both the experimental and control groups taken at week five were significantly higher than previous and subsequent measurements with no significant differences detected between groups.

Hafner (2008) explored the relationship between math self-efficacy, math anxiety and achievement among a sample of eighth grade students. The main purpose of this study was to examine the mediating role that math self-efficacy plays in the relationship between math anxiety and achievement among eighth grade students. A correlation design was utilized in order to examine these relationships. Two self-reports were administered to the students in order to quantify levels of math anxiety and math self-efficacy. The students’ most current grades in the subject of math were also incorporated into this study as the criterion variable. It was demonstrated that all three variables i.e. math anxiety, math self-efficacy and achievement were significantly correlated. Regression analyses also revealed that math
anxiety was a significant predictor of achievement but math self-efficacy mediated the relationship between math anxiety and achievement.

Liu and Koirala (2009) also found that mathematics self-efficacy is positively related to achievement of the students.

Telia (2011) examined an assessment of mathematics self-efficacy of secondary school students in Osun State, Nigeria. The study was drawn on 500 students comprising 250 males and 250 females randomly selected from five secondary schools in Osogbo. A self-efficacy instrument developed by Morgan and Jinks (1995) was adapted and mathematics achievement test having correlation of 0.72 were used for data collection. The t- test, Pearson product moment correlation and analysis of variance were used for analysis of data. The results indicated that significant difference exists in the mathematics self-efficacy of the subjects based on gender and age groups and that of mathematics achievement.

Mathematics self-efficacy is positively related to math performance (Pajares & Miller, 1994; Kabiri & Kiamanesh, 2004). This means that the higher a person rates on mathematics self-efficacy scales, the better that person performs on solving mathematical problems.

- **Review of Researches**

1.5.4 STUDIES RELATED TO MATHEMATICS ANXIETY

Walter, Denzler and Sarason (1964) concluded two studies on anxiety and the intellectual performance of high school students. In their studies several indices of anxiety were related to intellectual performances of high school students. Results of the first study agreed that test anxiety is more consistently related to test performance than are more general anxiety indices. The test anxiety was significantly and negatively related to intellectual test performance and not significantly related to grade point averages. In the second study, none of the measures of anxiety were significantly related to grades or intellectual test performance of boys. However, test anxiety was negatively related to both in case of girls.

Cowen, Zax, Klein, Izzo and Trost (1965) studied the relation of anxiety in school children to school record, achievement and behavioral measures. Responses of two independent samples of nine year old children (N = 178 and 216, respectively) on the Children's Manifest Anxiety Scale were correlated on a variety of achievement, behavioral, intellectual and socio metric measures. A very high proportion of significant correlations, always quite low in magnitude but very consistent across the two samples, emerged from these analyses. High anxiety was thus found to relate negatively to Intelligent Quotient and achievement scores.

Stevenson and Odom (1965) studied the relation of anxiety to children's performance on learning and problem solving tasks. A total sample of three hundred eighteen boys and girls at grades 4th and 6th were presented with abstract discrimination, paired associates, concept formation, concrete discrimination and anagrams tasks. Data were collected with the help of intelligence and achievement tests, teachers' ratings about children's general learning ability and socioeconomic status of the families. There was a significant negative correlation found between level of anxiety and performance on paired associates and anagrams and for grade 4th boys on the concept formation task. Verbal intelligent quotient, but not the performance intelligent quotient, tended to be correlated negatively with anxiety level. Teachers' ratings and achievement test scores were also generally negatively related to anxiety level. It is concluded that anxiety has the most disruptive effect on performance.

Chansky (1966) studied relationship between anxiety, intelligence and achievement in Algebra. To determine the relationships between anxiety, intelligence, and achievement in ninth grade algebra, the Children's Manifest Anxiety Scale, and the Primary Mental Abilities Test were administered to 23 boys and girls. A teacher made algebra test was administered at the end of the term. Tau correlations between Children's Manifest Anxiety Scale and
achievement were zero in boys but low negative in girls; tau correlations between Primary Mental Abilities number and achievement were low negative in boys, but low positive in girls. Partialling out the effect of aptitude did not change the correlation of Children's Manifest Anxiety Scale with achievement. A replication of the study with a second algebra class, but using a different teacher made term exam, yielded quite similar results. Again, anxiety and achievement were negatively correlated in girls, and numerical aptitude and achievement were negatively correlated in boys but positively correlated in girls.

Stanley (1970) studied the effect of anxiety over intellectual performance on reflection impulsivity in children. Anxiety over the quality of one's intellectual performance was hypothesized to influence the disposition of children to be impulsive or reflective in a problem solving task. It was found that anxiety aroused experimentally by having children fail in an intellectual task and its effects on decision time and errors on a match to sample task were assessed. The results also suggest that the induced anxiety resulted in longer decision times for both impulsive and reflective children and in fewer errors for the impulsive who increased in response time. This finding supported the proposition that anxiety over intellectual performance is one antecedent of a reflective cognitive disposition.

Fennema and Sherman (1976) found that math anxiety and math ability concepts were highly and negatively correlated ($r = -0.89$) in a sample of high school students. The math attitudes scales were used by the authors.

Patten (1983) investigated the relationships between both the Coppersmiths' Self-Esteem Inventory and the Sarason General Anxiety Scale for children and pear body individual achievement test. Eighty eight kindergartens through sixth grade learning disabled children placed in the regular classroom with resource help were tested individually by a certified learning disabilities teacher. The coefficients of correlation between all variables were determined for the total sample and for each sex with the help of Pearson product moment of correlation. The results concluded that significant relationships were found between (i) reading recognition, self-esteem and mathematics and general information achievement scores for the total group and females (ii) reading recognition, self-esteem and general information achievement scores for males (iii) general anxiety and general information achievement scores for the total group and for males (negative direction) and (iv) general anxiety and self-esteem for the total group and males (negative direction).

Clute (1984) studied the relationships between instructional method, mathematics anxiety and achievement in a survey course in college mathematics by using two instructional
strategies. One strategy consisted of a series of lectures structured to assist students in mastering an organized body of knowledge and the other was based on questioning sequences that guided students in discovering mathematical principles. Achievement was measured by an examination covering course content. Students with a high level of mathematics anxiety had significantly lower achievement than students with a low level of anxiety. There was significant interaction between method of instruction and level of anxiety suggested that students with high anxiety benefited more from the expository approach whereas students with low anxiety benefited more from the discovery approach.

Olson (1985) studied the causes and correlates of mathematics anxiety and mathematics achievement. The purpose of this study was to examine and explore the interrelationships among selected psychological variables related to achievement in mathematics. College undergraduates were measured on the following variables such as sex, sex-role orientation, field independence, spatial ability, number of mathematics courses taken, attitude toward mathematics, logical reasoning ability, locus of control, mathematics anxiety, trait anxiety, achievement anxiety and mathematics achievement. The goal of this research was to develop a plausible model which adequately represents the theorized causes of mathematics anxiety and the influences on mathematics achievement. The results of the path analysis found number of mathematics courses taken, spatial ability, logical reasoning ability and mathematics attitude to be important causal factors of achievement in mathematics. The factors that affect mathematics anxiety were trait anxiety, mathematics achievement, attitude toward mathematics and debilitating anxiety. A discriminant analysis was performed to investigate which variables were best at differentiating between low and high mathematics anxiety students. Mathematics achievement, mathematics attitude, field independence and the anxiety measures were found to be significant predictors of level of mathematics anxiety.

Wigfield and Meece (1988) assessed math anxiety in 6th through 12th grade children ($N = 564$) as part of a comprehensive longitudinal investigation of children's attitudes, beliefs and values concerning mathematics. The factor analyses provided evidence for two components of math anxiety i.e. a negative affective reactions component and a cognitive component. The worry component of math anxiety related more strongly and positively than did the affective component. But affective component of math anxiety related more strongly and negatively than did the worry component to children's performance perceptions, ability perceptions and math performance. Girls reported stronger negative affective reactions to
Introduction

math than did boys. Ninth grade students experienced the most worry about math and sixth graders experienced the least worry about math.

Hembree (1988) investigated the correlates, effects, causes and treatment of test anxiety. Results of 562 studies were integrated by meta analysis to show the effects, nature and treatment of academic test anxiety. Test anxiety causes poor performance. The test anxiety is related inversely to students' self-esteem and directly to fears of defensiveness, negative evaluation and other forms of anxiety. Conditions giving rise to differential test anxiety levels include gender, ability and school grade level. It was concluded that improved test performance and grade point average consistently accompany test anxiety reduction.

Hembree (1990) studied the nature, effects and relief of mathematics anxiety. Results of 151 studies were integrated by meta analysis to scrutinize the construct mathematics anxiety. Mathematics anxiety is negatively related to performance on mathematics achievement tests. It is related inversely to positive attitudes toward mathematics and is bound directly to avoidance of the subject. The variables that show differential mathematics anxiety levels include ability, school grade level and undergraduate fields of study with pre service arithmetic teachers especially prone to mathematics anxiety. However, mathematics anxiety appears more strongly linked with poor performance and avoidance of mathematics in pre-college males than females.

Meece, Wigfield and Eccles (1990) conducted a study on predictors of math anxiety and its influence on young adolescents’ course enrollment intentions and performance in mathematics. Structural modeling procedures were used to assess the influence of past math grades, performance expectancies, math ability perceptions and value perceptions on the level of math anxiety reported in a sample of two hundred fifty of 7th through 9th grade students. A second set of analysis examined the influence of these performances, self-perception and course enrollment intentions in mathematics and affect variables on students' subsequent grades. The findings indicated that math anxiety was directly related to students' performance expectancies, math ability perceptions and value perceptions. It was also found that students' performance expectancies predicted subsequent math grades whereas students' value perceptions predicted course enrollment intentions.

Bandalos, Thorndike-Christ and Yates (1995) studied the effects of perceived self-efficacy, math self-concept and attributions for failure and success on test anxiety. Structural equation modeling was used to test a model of test anxiety. The general test anxiety and statistical test anxiety were influenced by both failure and success attributions for both male
and female students. Men who those attributed failure to external causes were found to have higher levels of the worry component of statistical test anxiety. For women who attributed success to behavioral causes were found to have higher levels of math self-concept than women attributing success to external. Mathematics self-concept was negatively related to both general test anxiety and statistics test anxiety where as perceived self-efficacy had a negative relationship with the worry component of statistics anxiety.

Gupta (1998) studied anxiety level and school achievement among adolescents. Results indicated significant relation between anxiety level and academic achievement.

Newstead (1998) studied on aspects of children's mathematics anxiety. This study focused on mathematics anxiety in nine to eleven year old children and compared the mathematics anxiety of pupils taught in a traditional manner with that of pupils whose teachers adopted an alternative teaching approach emphasizing problem solving and discussion of pupils' own informal strategies. One finding was that pupils who were exposed to a traditional approach reported more mathematics anxiety than those who were exposed to other approach, particularly with regard to the public and social aspects of doing mathematics. The majority of pupils in this study reacted with either high or low anxiety to both aspects of doing mathematics.

Musch and Broder (1999) studied on test anxiety versus academic skills: A comparison of two alternative models for predicting performance in a statistics exam. Sixty six undergraduate students who were enrolled in the first semester of two parallel introductory statistics courses participated in the study. Both maths skill and test anxiety added unique variance in explaining performance. Maths skill also emerged as relatively more important than test anxiety but a purely deficit based account nevertheless appears untenable because interfering effects of test anxiety during the examination also contributed an important portion of variance.

Ma (1999) examined twenty six studies in meta analysis on the relationship between anxiety towards mathematics and achievement in mathematics among elementary and secondary students. The correlation for the relationship of common population is significant ($r = -0.27$). A series of general linear models indicated that the relationship is consistent across grade level groups, ethnic groups, gender groups, instruments measuring anxiety and years of publication. There is significantly difference in relationship among instruments measuring achievement as well as among types of publication. The researchers who used standardized achievement tests tend to report a relationship of significantly smaller
magnitude than researchers using mathematics teachers’ grades and researchers’ made achievement tests. Published studies tend to indicate significantly smaller magnitude of the relationships than unpublished studies. There exist no significant interaction effects among variables like ethnicity, grade and gender.

Ho, Senturk, Lam, Zimmer, Hong and Okamoto (2000) studied the affective and cognitive dimensions of math anxiety. In this study, the authors focused on math anxiety, comparing the dimensions and levels of math anxiety and relationship with mathematics achievement across samples of sixth grade students from China, Taiwan and the United States. The results of confirmatory factor analyses supported the theoretical distinction between affective and cognitive dimensions of math anxiety in all three national samples. The analyses of structural equation models provided evidence for the differential predictive validity of two dimensions of math anxiety. Specifically, across the three national samples, the affective factor of math anxiety was significantly related to mathematics achievement in the negative direction.

Onwuegbuzie (2000) studied on statistics anxiety and the role of self-perception. The relationship between seven dimensions of self-perception and six dimensions of statistics anxiety was investigated using a canonical correlation analysis. Participants were 146 students (aged 22–55 yrs) enrolled in graduate level research methodology courses. The results revealed that students with the lowest levels of perceived intellectual ability, scholastic competence and creativity tended to have the highest levels of statistics anxiety associated with interpretation anxiety, worth of statistics, computational self-concept, test and class anxiety, fear of asking for help and fear of the statistics instructor.

Hancock (2001) studied the effects of test anxiety and evaluative threat on students’ achievement and motivation. The author investigated the interactive effects of learner test anxiety, characteristic and threat of evaluation on the achievement and motivation of sixty one post secondary students assigned randomly to high or low evaluative threat conditions. The statistically significant interactions revealed that the students particularly the test anxious students perform poorly and were less motivated when exposed to highly evaluative classrooms.

Alam (2001) studied the academic achievement of Muslim and non-Muslim school children of Uttar Pradesh in relation to their anxiety level, socio-economic status and achievement motivation. Various tools and questionnaires were used for collection of the data. The data were tabulated and statistical treatment to the data was given using simple product
moment coefficient of correlation, t-test and skewness through computer. The findings of the study were significant having positive relationship between academic achievement and socio-economic status and negative relationship exists between academic achievement and anxiety, positive relationship between achievement motivation and academic achievement of Muslim and non-Muslim children. Both Muslim as well as non-Muslim children have significant inverse relationship between socio-economic status and anxiety. Socio-economic status goes along with higher achievement motivation. The academic achievement of non-Muslim children has been found superior in comparison to their Muslim counterparts. The non-Muslim children have lesser anxiety in comparison to Muslim children. In case of achievement motivation, non Muslim children are found to be superior to Muslim children.

Pancholi (2001) studied on an investigation into anxiety, reading ability, personality and sex of the pupils as predictors of mathematical conceptual understanding. The investigator administered reading ability test to initial sample of 780 pupils of sixth standard of the school randomly selected from Mehsana and Patan district. Finally, 160 pupils were given the conceptual understanding test mathematics. A 2x2x2 factorial design was employed. The investigator found that there is significant difference between the means of conceptual understanding scores of the pupils having high anxiety and low anxiety. Hence, anxiety played a crucial role in enhancing the conceptual understanding scores in mathematics.

Ashcraft (2002) suggests that highly anxious math students will avoid situations in which they have to perform mathematical equations. Math avoidance results in less exposure and math practice, less competency and leaving students more anxious. In college and university, anxious math students take fewer math courses and tend to feel negatively towards math. In fact, the author found strongly negative correlation between math anxiety and variables such as confidence and motivation. The author also found that when a highly math anxious student performs disappointingly on a math question; it could be due to math anxiety or the lack of competency in math because of math avoidance. He also noticed that highly math anxious individuals do well on the first portion of the test measuring performance. But on the latter and more difficult portion of the test, there was a stronger negative relationship between accuracy and math anxiety.

Hodge (2002) investigated the effect of math self-efficacy, math anxiety and computer assisted instruction on the ability of undergraduate nursing students to calculate drug dosages. The population of the study consisted of undergraduate nursing students at
Mountain State University (N=122), while the sample included students enrolled in a math topics for nurses course during the Spring Semester of 2002 (n = 40). Participants completed the Math Anxiety Scale, Math Self-Efficacy Scale and a Drug Dosage Calculation Exam. All students attended didactic lectures on oral and parenteral drug dosage calculations, as well as one on intravenous flow rates. After this, students attended either a traditional classroom or a computer lab to reinforce these concepts. Although data analysis indicated that math anxiety was a factor in nursing students’ ability to calculate drug dosages but it was not statistically significant. Furthermore, math self-efficacy and computer assisted instruction showed statistically significant relationships with undergraduate nursing students’ ability to calculate drug dosages.

Randhawa (2002) studied on academic achievement of school students as related to achievement motivation and test anxiety found that there is negative relationship between test anxiety and study habits.

Nwankwo and Kemjika (2003) investigated relationship between anxiety and academic achievement of secondary school students in Anambra State of Nigeria. The present study has striking revelation and implication for guidance and counseling in Nigerian secondary schools. The authors found that test anxiety has adverse effect on the academic achievement of students.

Sherman and Wither (2003) conducted a study on mathematics anxiety and mathematics achievement. This details a longitudinal study over five years of the relationship between mathematics anxiety and mathematics achievement. Observations of a cohort of students were made twice a year over a period of five years as they progressed from year 6 to year 10. The students were selected from three schools in suburban Adelaide in South Australia. The choices of schools were dictated by the need to follow the same students over the five years, so that all three schools needed to have both a primary and secondary component. Consequently, three non-government schools were chosen, as, at the time, the only government schools in South Australia with both primary and secondary components were rural area schools. It was determined that the logistics of the study would not have been feasible with such schools. While administration of the each test, the whole relevant year level at each of the schools was tested with numbers ranging from 156 in the first testing to 289 for the first year 8 tests. All nine testing sessions were completed by 66 of the original 156 students. The results were a complete surprise to the authors; the expectation was that the observations would support the hypothesis that mathematics anxiety caused a deterioration of
mathematics achievement particularly as observation of results of intervention would appear to support this hypothesis (Hembree, 1990). But there is insufficient evidence to show a significant difference between the other two i.e. whether poor mathematics achievement causes mathematics anxiety or whether there is a third factor causing both.

Woodard (2004) studied the effects of math anxiety on post secondary developmental students as related to achievement, gender and age. A total sample of 125 developmental math students (33 males and 92 females) from Southwest Virginia Community College was included in the study. The study was conducted with forty five basic math students, fifty one algebra I students and twenty nine algebra II students. The tool used to measure the math anxiety levels of the students was the Mathematical Anxiety Rating Scale (MARS). Pearson Product Moment Correlation was used on the anxiety scores and exit exam scores to find relationships between the anxiety levels of the students and their achievement scores. A significantly low negative relationship was found between exit exam scores and math anxiety scores (r = -0.20). This indicated that achievement scores decreases with the increase in math anxiety scores.

Saini (2004) in his study on effect of programmed instructional material on achievement in Geography in relation to anxiety found that there is no significant difference in mean gain scores in achievement in geography instructional material between high and low anxiety groups and average and low anxiety groups.

Mokashi (2007) conducted a study on correlates of anxiety and scholastic achievement of residential school students. The sample of 330 students for the study consisted of all the students studying in eighth, ninth and tenth standard from Kittur Rani Chennamma School of Kittur and Sainik School of Bijapur was taken. Expost – facto research design aimed to identify the relationship between anxiety and scholastic achievement of the residential school students. The analysis of frequency and percentage was used to interpret the level of anxiety, personal characteristics and scholastic achievement of the respondents. Karl-Pearson’s product moment correlation coefficient analysis was carried out to assess the degree of relationship between anxiety and scholastic achievement. The results indicated that there was a significant negative relationship between anxiety and scholastic achievement of the respondents.

Yuksel-Sahin (2008) studied on mathematics anxiety among fourth and fifth grade Turkish elementary school students. This study investigated whether students’ mathematics anxiety differed significantly according to a group of variables. A total sample of 249
students participated in the study. The mathematics anxiety scale and the personal information form were used for data collection. Independent samples t-tests, one way analysis of variance and Schefee test were used for analysis of the data. Students who liked mathematics class and those who liked their mathematics teachers had lower anxiety. The students with higher achievement in mathematics had lower degrees of mathematics anxiety.

Zakaria and Nordin (2008) studied the effects of mathematics anxiety on matriculation students as related to motivation and achievement. A sample of 88 students was taken who were at the end of their second semester of study. Fennema Sherman Math Anxiety Scale and Effectance Motivation Scale were used to measure anxiety and motivation respectively. An analysis of variance showed that the mean achievement scores and motivation scores of high, moderate and low anxiety groups were significantly different. Findings showed a low but significant negative correlation \( r = -0.32 \) between mathematics anxiety and achievement and also a strong significant negative correlation \( r = -0.72 \) between mathematics anxiety and motivation. The results also showed a significant low positive correlation \( r = 0.31 \) between motivation and achievement.

Olatunde (2009) investigated the relationship between mathematics anxiety and student academic achievement in selected secondary schools in Southwestern Nigeria. Descriptive survey method was adopted for this study. Two validated instruments were used in collecting data for the study and simple percentages were used in analyzing the data. The total sample of 1750 senior secondary school students was selected from two secondary schools in each of the Senatorial districts in Southwestern part of Nigeria. The findings showed that many of the students were afraid of mathematics because of the fear of math subject and the fear of failing tests in maths. The findings also revealed that majority of the students do not know how to study for mathematics tests. The authors recommended that stakeholders should organize propaganda in the media to educate students, parents and the general public about mathematics to allay their fear of the subject.

Sun and Pyzdrowski (2009) used a meta analytic approach based on a review of the literature to address mathematics anxiety through the use of technology. For this, authors reviewed various definitions of mathematics anxiety and factors that are associated with this phenomenon. Known causes and uses of technology that may effectively reduce mathematics anxiety are presented by the authors. Selected software and websites are also reviewed for their positive influence on reducing mathematics anxiety of students.
Wei (2010) conducted a study to investigate the impact of the mathematics anxiety treatment messages in a computer based environment on ninth grade students’ mathematics anxiety and mathematics learning. A sample of 161 ninth grade students was selected who took an introductory algebra class in a public high school neighboring Utah State University. Their learning environment was integrated with a pedagogical agent as a tutor. A pre-test and post-test experimental design was employed in this study. The mathematics anxiety of participants was measured at the beginning and at the end of the intervention. The mathematics learning of participants was also measured before and after each lesson. The participants in selected sample were randomly assigned to work with either an agent presenting mathematics anxiety treatment messages or an agent without presenting the treatment messages. Because of student attrition, only 128 students were included for data analysis. The results suggested that (i) mathematics anxiety treatment messages provided by a pedagogical agent had no impact on student mathematics anxiety and mathematics learning (ii) there were no main or interaction effects of the treatment messages and learners’ gender on mathematics anxiety and mathematics learning (iii) there were significant interaction effects between treatment messages and learner’s prior mathematics anxiety levels only on current mathematics anxiety. High anxious students in the treatment messages condition decreased their anxiety more than those in the no treatment messages condition. Medium anxious students in the treatment messages condition increased their anxiety whereas those in the no treatment messages condition decreased their anxiety. Low anxious students in the treatment messages condition did not change their anxiety whereas those in the no treatment messages condition increased their anxiety.

Beilock, Gunderson, Ramirez and Levine (2010) reported that people’s fear and anxiety about doing math can be a hindrance to their math achievement. They showed that math anxious female elementary school teachers carry negative consequences for the math achievement of their female students. First and second grade female teachers completed measures of math anxiety and the math achievement of the students in these teachers’ classrooms was also assessed. It found that there was no relation between a teacher’s math anxiety and her students’ math achievement at the beginning of the school year. But by the school year’s end, the more anxious teachers were about math, the more likely girls were to endorse this stereotype that boys are good at math and girls are good at reading and this results in lower math achievement of girls.
Gupta and Verma (2011) investigated effect of self-efficacy and test anxiety among college students in relation to academic achievement. The descriptive survey method was used by the investigators. In present study, the investigators had drawn a sample of 200 students from colleges through purposive sampling and 3×2 analysis of variance was used. The findings revealed that high test anxiety among girls than their counterparts prevailed. Present study suggests lower performance with higher test of anxiety and there exists no interaction effect of achievement and gender on test anxiety.

• Review of Researches


1.6 NEED AND SIGNIFICANCE OF THE STUDY

Mathematics anxiety among students has risen in the last few years. Mostly students avoid mathematics and decide on their program of study based on the math courses needed to complete the degree requirement. Mathematics anxiety is not an intellectual problem but an emotional problem, which can be overcome. Overcoming their fear of mathematics is necessary for the student to be able to become successful in mathematics courses.
Mathematics is different from other subjects and must be studied differently. Mastering effective study techniques for mathematics enhances mathematics performance. Better use of time and developing a study schedule also assists in improving mathematics performance.

Anxiety is only when people cannot predict or exercise control over events that they have reason to fear them. Efficacy beliefs predict how much fear arousal they experience and how well people cope with threats. Even when the effects of anxiety are controlled, self-efficacy will retain predictiveness of performance, whereas the effect of anxiety should dissipate when self-efficacy percepts are controlled (Bandura, 1986).

According to Isman (2005), “The education and technology play an important role in the education of humans. The education and technology are two different concepts, but the use of both resulted in the emergence of a new discipline called the educational technology. Educational technology makes the teaching and learning activities more enjoyable. Students learn by playing and enjoying these activities”.

“Computer attracts students very much. The use of the audio-visual devices, presentations and animations with instructional materials results in the enjoyable and productive learning process. So, the learning process can become enjoyable and interesting for students as a result of abolishing traditional classroom learning activities. Technological developments give rise to new teaching and learning facilities. Educational technology especially computers play an important role in concretizing abstract concepts, which are difficult for children to learn by means of animations” (Akpinar, 2005).

“The computer based instruction makes teaching techniques far more effective than those of the traditional teaching methods as it is used for presenting information, testing, evaluation and providing feedback. It makes a contribution to the individualization of education. It acts as motivator for the students and students remain as active part in the whole learning process. It develops creativity and problem solving skills, identity and self-reliance in learners. Computer based instruction provides graphics, animation, drawings, music and plenty materials for the students to proceed at their own pace and in line with their individual differences. It controls lot of variables having an impact on learning, which cannot be controlled by means of traditional educational techniques” (Chang, 2002). “The use of computer based education increases students’ attitudes and achievements significantly” (Berger, Lu, Belzer & Voss, 1994; Geban, 1995). According to Renshaw and Taylor (2000),
"It has been found that computer based instruction serves to develop meta-cognitive skills in students and helps them to learn in a meaningful way instead of rote-memory learning as well as it enables the students to increase their achievements”. “According to some studies there is no significant difference between the computer based instruction and traditional teaching methods” (Bayraktar, 2001; Alacapinar, 2003).

The study aims to test the effects of the use of computer based instruction technology is thought to be important which triggers active participation and enables students to make their own meaning. At present, it has been observed that classroom instructions have become too aversive, too negative and improperly sequenced. Thus flexibility in instructional strategy is needed so that students’ can work at their own speed and participate actively in the learning process.

A revolution is taking place in education. The technology transforms education from faulty centered to learner centered and making instructions better by replacing the “sage on the stage” with interactive individualized learning possibilities. One of the technological revolutions is the use of computers. It is ought to be emphasized that the role of computers in curriculum based on realization of their unique attributes, has a large importance in education.

Keeping in view the review of researches, it is observe that factors like mathematics self-efficacy and mathematics anxiety affect the achievement in one way or the other way. Therefore, the investigator tried to study the effect of computer based instruction on achievement in mathematics in relation to mathematics self-efficacy and mathematics anxiety. Number of studies has been conducted with students at middle school level regarding mathematics achievement but fewer have focused on individual differences like mathematics self-efficacy and mathematics anxiety. This also fascinated the investigator to explore this area to find out the relevance of computer based instruction in relation to mathematics self-efficacy and mathematics anxiety.

The aim of mathematics education is not to load the students’ with knowledge but to contribute to their mental development also. Therefore, content and methodology of mathematics teaching should be organized and systematic in such a way that leads to high achievement in mathematics. Anyone can be mathematician. Any person with average intelligence can master the science of mathematics with proper guidance and training (Devi, 2002).
1.7 STATEMENT OF THE PROBLEM

EFFECT OF COMPUTER BASED INSTRUCTION ON ACHIEVEMENT IN MATHEMATICS IN RELATION TO MATHEMATICS SELF-EFFICACY AND MATHEMATICS ANXIETY

1.8 OPERATIONAL DEFINITION OF THE VARIABLES

(i) **Computer Based Instruction**: Computer based instruction can be simply defined as the delivery of information with the help of computer. It can be further explained as “the use of a computer to argument classroom, providing instruction and course content in the form of drill and practice, exercise and tutorials”.

(ii) **Traditional Method of Teaching**: Traditional lecture is an exposition of knowledge, facts, principles or other information which a teacher wishes to present to his pupils. While using this method, the teacher assumes that students possess sufficient background and ability to understand the lecture.

(iii) **Achievement**: Achievement means performance in a particular subject area or courses, usually by reason of skills, hard work and interest summarized in various types of marks, grades or scores. The achievement test is an investigator made test. It involves the set of questions from selected units of mathematics for 9th class students.

(iv) **Mathematics Self-Efficacy**: Mathematics self-efficacy is assessed as individuals' judgments of their capabilities to perform math-related tasks, to solve specific math problems or succeed in math-related courses.

(v) **Mathematics Anxiety**: Mathematics anxiety refers to a state of uneasiness and distress about mathematics and the taking of mathematics tests.

1.9 DELIMITATIONS

The study was delimited with respect to the following aspects:

(i) The intelligence of students was assessed with respect to general mental ability test because this is the most important factor affecting achievement.

(ii) The study was confined to 9th class mathematics students of English medium schools from Jalandhar city affiliated to Punjab School Education Board, Mohali.

(iii) Fifteen lessons based on computer based instruction and traditional method of teaching were prepared in mathematics only.

(iv) The students were taken from four high senior secondary schools of Jalandhar city.
The study was confined to two classifying variables i.e. mathematics self-efficacy and mathematics anxiety.

1.10 OBJECTIVES

The study was conducted on the basis of following objectives:
1. To develop the mathematics self-efficacy scale.
2. To develop computer based instructional material for selected units of mathematics.
3. To develop a criterion test in mathematics for selected units of mathematics.
4. To develop an achievement test in mathematics for selected units of mathematics.
5. To compare the achievement of group taught through computer based instruction and conventional group in mathematics.
6. To compare the achievement of high and low groups of students on mathematics self-efficacy.
7. To compare the achievement of high, average and low groups of students on mathematics anxiety.
8. To examine the interaction effect of instructional strategies and mathematics self-efficacy.
9. To study the interaction effect of instructional strategies and mathematics anxiety.
10. To find out the interaction effect of mathematics self-efficacy and mathematics anxiety.
11. To examine the interaction effect among instructional strategies, mathematics self-efficacy and mathematics anxiety.

1.11 HYPOTHESES

The study was designed to test the following hypotheses in the study:

H10: The achievement of group taught through computer based instruction is significantly higher than that of conventional group in mathematics.

H20: The achievement of high mathematics self-efficacy group is significantly higher than that of low mathematics self-efficacy group of students in mathematics.

H30: The achievement of low mathematics anxiety group is significantly higher than that of average and high mathematics anxiety group of students in mathematics.

H40: There exists no significant interaction effect of instructional strategies and mathematics self-efficacy.
H5O: There exists no significant interaction effect of instructional strategies and mathematics anxiety.

H6O: There exists no significant interaction effect of mathematics self-efficacy and mathematics anxiety.

H7O: There exists no significant interaction effect among instructional strategies, mathematics self-efficacy and mathematics anxiety.