Chapter VI

Summary and Conclusions
CHAPTER – VI
SUMMARY AND CONCLUSIONS

6.1 INTRODUCTION

Mathematics Education faces a number of challenges at all educational levels, from school to university. Challenges are both at the level of society and at the level of individual. At the former level, society needs a well educated population, to actively contribute to the shaping of society, and a broadly qualified workforce, all of whom are able to activate mathematical knowledge, insights and skills in a variety of situations and contexts. At the individual level, this is reflected in the so-called “relevance paradox”. Even though mathematical knowledge is highly relevant in and to society, many, if not most, people have increasing difficulty at seeing that mathematics is relevant to them, as individuals. The need of the hour is to develop coherence in mathematics as a subject at all levels.

Competency Based Education (CBE) emerged in the United States in the 1970s and refers to an educational movement that advocates defining educational goals in terms of precise measurable descriptions of knowledge, skills, and behaviors students should possess at the end of a course of study. It focuses on outcomes of learning. CBE addresses what the learners are expected to do rather than on what they are expected to learn about. Competency-based education is a systematic but flexible learning process which focuses on defining in measurable terms what students are to learn. Expected behaviors, conditions for their performance, and acceptable standards are specified in advance. Mastery of competencies is determined by evaluation of knowledge and skills utilizing varied assessment methods. Competency-based education and training is an educational philosophy and practice that places heavy emphasis on skill attainment and proficiency. The goal of this movement is to help students master a skill to a level deemed proficient. The educational system is built around fostering proficiency in each student. The development of objective standards that determine what may be called competent and proficient is also a concern of this movement.

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In other words, Competency Based Education is an institutional process that moves education from focusing on what academics believe graduates need to know (teacher-focused) to what students need to know and be able to do in varying and complex situations (student and/or workplace focused). Competency Based Education is focused on outcomes (competencies) that are linked to workforce needs, as defined by employers and the profession. The outcomes are increasingly complex in nature, rather than deriving from the addition of multiple low level objectives. The process often necessitates more complex assessment, involving experiential learning assessment in field experience, demonstration in varying contexts, role play, use of standardized patients or clients, etc. Large skill sets are broken down into competencies, which may have sequential levels of mastery. Competencies reinforce one another from basic to advance as learning progresses; the impact of increasing competencies is synergistic, and the whole is greater than the sum of the parts. Competencies within different contexts may require different bundles of skills, knowledge and attitudes. The challenge is to determine which competencies can be...
bundled together to provide the optimal grouping for performing tasks. Another challenge is designing learning experiences that support students as they practice using and applying these competencies in different contexts. Continual refinement of defined competencies is necessary so that enhanced performance in a variety of contexts can be assessed. In essence, Competency Based Education is a process, not a Product. The process of competency based education can be depicted as in figure below. Hierarchically, the process of competency based education program can be demonstrated as below.

Figure 6.2

Showing the hierarchical relationships in competency-based education program

Hierarchical Relationships

6.1.1 Competency

A competency is simply a statement of learning outcomes for a skill or a body of knowledge. When students demonstrate a "competency," they are demonstrating their ability to do something. They are showing the outcome of the learning process. Lots of the things that people do in their lives can be defined as different competencies - job skills, living skills, etc. A competency refers to an individual's
demonstrated knowledge, skills, or abilities (KSAs) performed to a specific standard. Competencies are observable, behavioral acts that require a combination of KSA’s to execute. They are demonstrated in a job context and, as such, are influenced by an organization’s culture and work environment. In other words, competencies consist of a combination of knowledge, skills, and abilities that are necessary in order to perform a major task or function in the work setting.

6.1.2 Mathematical Exit Competencies

Exit competencies are knowledge, skills and attitudes, a student must be able to demonstrate prior to completion of a training program. Mathematical exit competencies for mathematics teachers/prospective mathematics teachers are the competencies essential for effective mathematics teaching learning process; and that the prospective mathematics teachers must be able to demonstrate these abilities prior to completion of the training program. All mathematical exit competencies have a dual nature, as they have an analytical and productive aspect.

**Figure 6.3**

*Shows dual nature of a mathematical exit competency*

The analytical aspect of a mathematical competency focuses on understanding, interpreting, examining and assessing mathematical phenomena and processes; such as, for instance, following and controlling a chain of mathematical arguments or understanding the nature and use of some mathematical representation, whereas the
productive aspect focuses on the active construction or carrying out of processes, such as inventing a chain of arguments or activating and employing some mathematical representation in a given situation.

6.2 EMERGENCE OF THE PROBLEM

The concept of a competency-based education system is both an old and an evolving idea, details of which are still being worked out, especially in relation to higher education institutions and the professions. There is a commonly expressed belief that institution-based courses too often emphasize theoretical or ‘book’ knowledge at the expense of the ability to apply knowledge to perform practical tasks and to fulfill workplace roles (Tuxworth 1989; Jessup 1989). Competency-based education is perceived by some as the answer, by others as the wrong answer, to the improvement of education and training for the complex contemporary world (Harris et al. 1995). Competence is a contested concept, the meaning of which is shaped by those who use it (Chappell, 1996). Proponents of competency-based education and training promote it as a way to improve the correspondence between education/training and workplace requirements (Harris et al. 1995). It is individualized, emphasizes outcomes (what individuals know and can do), and allows flexible pathways for achieving the outcomes. It makes as clear as possible what is to be achieved and the standards for measuring achievement. In theory, it overcomes the divide between hands and mind, theory and practice, general and vocational education.

For its opponents, competency-based education and training is excessively reductionist, narrow, rigid, atomized, and theoretically, empirically, and pedagogically unsound (Hyland, 1994; Chappell, 1996). Despite of these oppositions/inconclusive results, efforts are being made to use this approach as a training program for professionals. The imperfect nature of effectiveness of competency-based training on professional’s performance has left much scope for explanation to account for an individual’s performance. The long felt need to shift from ‘learning material containing piecemeal practices of isolated knowledge’ to ‘thinking holistically in terms of the whole authentic task that competent professionals perform’ has motivated various researchers to investigate in this field. Some work has
been done to identify skills specific to mathematics teaching (Hamlett, 1978; Shulman, 1992; Fennema and Franke, 1992; Cochran et al., 1993; Niss, 2002; Ministry of education, Ontario, 2005; Jumani, Akhlaq, Malik, Chisht and Butt, 2010); but the work done in Indian situations is too scanty. This gives rise to the need of competency-based education programs which emphasize on the specification and assessment of outcomes; address an ongoing concern over the workplace relevance of much of the content of formal educational programmes; and, to express outcomes as explicit, observable workplace performances.

Review of literature highlights that while certain attempts have been made in the area of teacher assessments designed to measure essential teaching skills, there is still lack of research on assessing exit competencies of teachers. The investigator found that various efforts have been made in developing assessment tools for mathematics teachers in other countries (Koirala, Davis and Johnson, 2008), Alnoor and Yu (2010). The researcher could not locate any research study based on developing exit competency based assessment tool for mathematics teachers/prospective teachers in Indian situations. It has also been argued that the competency-based programs must be criterion referenced and criterion being the development of requisite competencies before exiting the program. So assessment of these exit competencies is an essential element of competency-based programs.

Also, review of literature highlights the increasing concern for revamping pre-service courses in order to enable the prospective teachers to understand how to correlate their competencies applies to their teaching. Various research attempts have been made to identify mathematical exit competencies essential for a mathematics teacher (Niss (2002), Ministry of education, Ontario (2005), Jumani, Akhlaq, Malik, Chisht and Butt (2010), Cochran et al. (1993), Shulman (1992), Fennema and Franke (1992), Hamlett (1978)). Most of the studies located by the investigator were conducted in the advanced countries. The investigator could not locate any such study conducted in Indian situations. The investigator could also locate few research studies on identification of mathematical competencies, like, mathematical content knowledge, questioning, mathematical communication, mathematical representations, etc. (Bloom (1994), Porter (1993), Brahiar (1993), Farmer and Farrell (1989), Peker and Erdogan (2009), Neria and Amit (2004), Bly (1986), Cook-Gumperz (1982), Goodlad (1984), Sadker and Sadker (1985), Erickson (1975), Erickson and Schultz (1981), Hall and Sandler (1982)). The investigator could locate a few experimental
studies (Jumani, Akhlaq, Malik, Chisht and Butt (2010), Mayer and Greeno (1972), Peker and Erdogan (2009)). Most of the studies were survey studies. The research work done in this field is scanty. Extensive experimental research needs to be done in this field of mathematical exit competencies for mathematics teachers in Indian conditions.

Also, the investigator could locate very few research studies on achievement motivation of teachers (Carlson, 1973). Different literature identifies various important factors on which teacher’s motivation and competence is based on (Johnson (1986), Hawley (1985)). The literature reveals that research work on achievement motivation level of teachers is too scanty. Moreover, the work done is descriptive / suggestive in nature (Pelletier and et. al, (2002), Dormy (2001), Johnson (1986)). The investigator could locate only one experimental study (Carlson, 1973). This area needs to be explored widely for prospective teacher / teacher population. This highlighted the need for research in this field.

The perusal of literature on teaching aptitude revealed that there are studies which indicate the positive relationship between teaching aptitude and teacher effectiveness (Sharma (1971), Babu & Rao (2007), Khatal (2010)). The investigator could not locate any research study on relationship between teaching aptitude and exit competencies of a mathematics teacher / prospective teacher. Also, the investigator could not find any experimental study assessing the effectiveness of training strategies on prospective teachers / teachers with high teaching aptitude and low teaching aptitude. The research work in this area needs to be explored widely. Moreover, the above cited studies revealed that various researchers have explored whether aptitude can be increased through specialized instruction (Politser and Weiss, 1969; Harley and Hart, 1997).

The trend of research work in field is scanty. There is still scope for further exploration.

6.3 STATEMENT OF THE PROBLEM

The present problem reads as:-

EFFECTIVENESS OF COMPETENCY-BASED APPROACH IN DEVELOPING EXIT COMPETENCIES AMONG PROSPECTIVE MATHEMATICS TEACHERS IN RELATION TO ACHIEVEMENT MOTIVATION AND TEACHING APTITUDE
6.4 MATHEMATICAL EXIT COMPETENCIES INCLUDED IN THE PRESENT STRATEGY

The Mathematical Exit Competencies included in Mathematics Competency Based Training Strategy (MCBTS) were as under:

1. Mathematics Content Competencies

The mathematical exit competency ‘Mathematics Content Competencies’ refers to proficiency of a mathematics prospective teacher / teacher in mathematics content and its delivery. It deals with expertise in, knowledge of mathematics content; giving illustrations with examples; selection and organization of mathematics content; and making mathematical connections.

2. Mathematics Process Competencies

The mathematical exit competency ‘Mathematics Process Competencies’ refers to proficiency of a mathematics prospective teacher / teacher in dealing with processes involved in mathematics teaching learning process. It focuses on expertise of a mathematics teacher in, communicating mathematical ideas and concepts; questioning in classroom and manage the responses given by students appropriately; developing problem solving ability through thinking process; and, evaluating classroom teaching learning process.

3. Mathematical Pedagogical Competencies

The mathematical exit competency ‘Mathematical Pedagogical Competencies’ refers to expertise of a mathematics prospective teacher / teacher in dealing with various pedagogical practices essential for an effective mathematics classroom. It focuses on proficiency of a mathematics teacher in, utilizing blackboard as a teaching aid in mathematics classroom; and, application of instructional strategies in mathematics teaching learning process.

Mathematical Exit Sub-Competencies included under Mathematical Exit Competencies in Mathematics Competency Based Training Strategy (MCBTS) were as under:

1. Mathematics Content Competencies

- Mathematics Content Knowledge
- Illustrating with Examples
• Selection and Organization of Mathematics Content
• Mathematical Connections

2. Mathematics Process Competencies
• Mathematical Communication
• Questioning and Response Management
• Mathematical Problem Solving
• Evaluation

3. Mathematical Pedagogical Competencies
• Black Board Writing
• Multiple Instructional Strategies

6.5 OPERATIONAL DEFINITIONS OF TERMS USED

The terms used in the present study are operationally defined as under:

1. **Mathematical Exit Competencies**: Mathematical Exit competencies are knowledge, skills and attitudes, a prospective mathematics teacher must be able to demonstrate prior to completion of mathematics teacher training program.

The following three Mathematical Exit Competencies were identified and selected; and are operationally defined as below:

a. **Mathematics Content Competencies**: This Mathematics Exit Competency include sub-competencies specifically related to mathematical content, giving illustrations with examples, selection and organization of mathematics content and making mathematical connections. In the present study, Mathematics Content Competencies means the exit competencies as measured/assessed by the rating scale prepared by the investigator.

This Mathematical Exit Competency included the following four Mathematical Exit Sub-Competencies:-

i. **Mathematics Content Knowledge**: - Mathematics content knowledge deals with the teaching process, including the most useful forms of
representing and communicating content and how student’s best learn
the specific concepts and topics of mathematics. In the present study,
Mathematics Content Knowledge means the Mathematical Exit
Competency as measured/assessed by the observation schedule
developed by the investigator.

ii. **Illustrating with Examples:** The act of illustrating refers to the act
of making clear and distinct; also, that which illustrates using a
comparison or example intended to make clear or apprehensible, or to
remove obscurity. In a subject like mathematics, concrete examples
will really help students to understand the concepts to be taught in
class. In the present study, Illustrating with Examples means the
Mathematical Exit Competency as measured/assessed by the
observation schedule developed by the investigator.

iii. **Selection and Organization of Mathematics Content:** Mathematics
content builds coherently from grade-to-grade; students have the
opportunity to build upon their learning year-to-year; each year, the
content increases in complexity and is appropriately challenging. In the
present study, Selection and Organization of Mathematics Content
means the Mathematical Exit Competency as measured/assessed by the
observation schedule developed by the investigator.

iv. **Mathematical Connections:** A Mathematical Connection helps
students recognize how ideas in different areas are related. 
Mathematical Connections can relate mathematical topics to students’
daily lives and to other mathematical topics but are probably most
important in relating mathematics to other curriculum areas. In the
present study, Mathematical Connections means the Mathematical Exit
Competency as measured/assessed by the observation schedule
developed by the investigator.

b. **Mathematics Process Competencies:** This Mathematical Exit Competency
includes Exit Sub-Competencies specifically related to communication in
mathematical language, technique of questioning and dealing with responses
given by students, problem solving ability in mathematics, and evaluation. In
the present study Mathematics Process Competencies means the Mathematical Exit Competencies as measured/assessed by the rating scale prepared by the investigator.

This Mathematical Exit Competency included the following four Mathematical Exit Sub-Competencies:-

i. **Mathematical Communication:** - Through Mathematical Communication, mathematical ideas become objects of reflection, refinement, discussion and amendment. The Communication process in mathematics helps build meaning and permanence for ideas and makes them public. In the present study, Mathematical Communication means the Mathematical Exit Competency as measured/assessed by the observation schedule developed by the investigator.

ii. **Questioning and Response Management:** - Asking questions in mathematics is a fundamental part of finding information and for subtle (and otherwise) persuasion. Responses given by students may be complete, partially correct or null responses. The effective management of such responses in a mathematics classroom can make the teaching-learning process in mathematics more effective. In the present study, Questioning and Response Management means the Mathematical Exit Competency as measured/assessed by the observation schedule developed by the investigator.

iii. **Mathematical Problem Solving:** - Problem solving forms part of thinking. Problem solving is an integral part of all mathematics learning. Teachers play an important role in developing students' problem-solving dispositions. In the present study, Mathematical Problem Solving means the Mathematical Exit Competency as measured/assessed by the observation schedule developed by the investigator.

iv. **Evaluation:** - Evaluation serves as the basis for the improvement of the way activities are carried out in a classroom. Evaluation is also an effort at discovering whether certain activities have led to desired effects or outcomes. In the present study, Evaluation means the Mathematical Exit Competency as measured/assessed by the observation schedule developed by the investigator.
c. **Mathematical Pedagogical Competencies:** The Mathematical Exit Competency Mathematical Pedagogical Competencies includes Exit Sub-Competencies specifically related to Black-Board Writing and Multiple Instructional Strategies. In the present study Mathematical Pedagogical Competencies means the Exit Competencies as measured/assessed by the rating scale prepared by the investigator.

This Mathematical Exit Competency included the following two Mathematical Exit Sub-Competencies:-

i. **Black Board Writing:** - The Blackboard is a teacher’s best visual aid when question arises that involves the whole class. A mathematics teacher can organize discussions on it, emphasize major points, makes note of page numbers for assignments, and work with examples by writing problems. In the present study, Black board writing means the mathematical exit competency as measured/assessed by the observation schedule developed by the investigator.

ii. **Multiple Instructional Strategies:** - Instructional strategies are the methods that are used in the lesson to ensure that the sequence or deliveries of instruction help students learn. A mathematics teacher understands and uses a variety of instructional strategies i.e. multiple instructional strategies to encourage student’s development of critical thinking, problem solving and performance skills. In the present study, Multiple Instructional Strategies means the mathematical exit competency as measured/assessed by the observation schedule developed by the investigator.

- **Mathematics Teaching Competency** refers to the competency of a mathematics teacher in a classroom situation. In the present study Mathematical Teaching Competency is as measured / assessed by Mathematical Teaching Competency Assessment Scale (MTCAS), developed by the investigator.

2. **Achievement Motivation:** - Achievement Motivation is a task-oriented behaviour that allows the individuals performance to be evaluated according to some internally and/or externally imposed criterion. It involves the individual in competing with others at some standards of excellence. In the present study,
Achievement Motivation means the scores obtained by prospective mathematics teachers on Achievement Motive Test (ACMT) by Bhargava (1994).

3. Teaching aptitude: - Teaching Aptitude is a capacity to acquire proficiency or skill, with a given amount of training. Teaching Aptitude is necessary for the teachers to do their holy job a successful one. Without having considerable amount of Teaching Aptitude, no teacher can make teaching learning process effective. In the present study, Teaching Aptitude means the scores obtained by prospective mathematics teachers on Teaching Aptitude Scale (TAS) by PSY-COM SERVICES.

6.6 DELIMITATIONS OF THE STUDY
The delimitations of the present study were as under:

1. The present study was confined to a sample of 126 prospective mathematics teachers from self-financed education colleges affiliated to Punjabi University, Patiala.

2. The effectiveness of the Mathematics Competency Based Training Strategy was assessed in terms of Mathematical Exit Competencies identified by the investigator.

3. The study was delimited in terms of Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, Mathematics Teaching Competency as dependent variables; Training Strategies as independent variable; and Achievement Motivation and Teaching Aptitude as classifying variables.

4. The study was delimited with respect of the tools, namely, Observation schedules for ascertaining the acquisition of Mathematical Exit Sub-Competencies; Rating scales developed by investigator to measure Mathematics Content Competencies, Mathematics Process Competencies and Mathematical Pedagogical Competencies; Mathematics Teaching Competency Assessment Scale (MTCAS) developed by the investigator; Achievement Motive Test (ACMT) by Bhargava (1994); and, Teaching Aptitude Scale (TAS) by PSY-COM Services (1996). The results were guided by the data.
collected by these tests and interpretations were governed by the theoretical considerations underlying these tests.

5. The duration of the treatment was 60 days and on an average treatment was given for two hours daily.

6.7 OBJECTIVES OF THE STUDY

The objectives of the present study were as under:

1. To develop and standardize a scale on Mathematics Teaching Competency.

2. To develop Competency Based Teacher Training Strategy for prospective secondary school mathematics teachers.

3. To develop and validate, Observation Schedules and Rating Scales on Exit Competencies required by prospective mathematics teachers.

4a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematics Content Competencies.

4b. To study whether the prospective mathematics teachers having High Achievement Motivation and Low Achievement Motivation differ in mean gain scores on Mathematics Content Competencies.

4c. To find if there is any interaction effect between Training Strategies and Achievement Motivation on Mathematics Content Competencies.

5a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematics Process Competencies.

5b. To study whether the prospective mathematics teachers having High Achievement Motivation and Low Achievement Motivation differ in mean gain scores on Mathematics Process Competencies.

5c. To find if there is any interaction effect between Training Strategies and Achievement Motivation on Mathematics Process Competencies.

6a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematical Pedagogical Competencies.
6b. To study whether the prospective mathematics teachers having High Achievement Motivation and Low Achievement Motivation differ in mean gain scores on Mathematical Pedagogical Competencies.

6c. To find if there is any interaction effect between Training Strategies and Achievement Motivation on Mathematical Pedagogical Competencies.

7a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematics Teaching Competency.

7b. To study whether the prospective mathematics teachers having High Achievement Motivation and Low Achievement Motivation differ in mean gain scores on Mathematics Teaching Competency.

7c. To find if there is any interaction effect between Training Strategies and Achievement Motivation on Mathematics Teaching Competency.

8a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematics Content Competencies.

8b. To study whether the prospective mathematics teachers having High Teaching Aptitude and Low Teaching Aptitude differ in mean gain scores on Mathematics Content Competencies.

8c. To find if there is any interaction effect between Training Strategies and Teaching Aptitude on Mathematics Content Competencies.

9a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematics Process Competencies.

9b. To study whether the prospective mathematics teachers having High Teaching Aptitude and Low Teaching Aptitude differ in mean gain scores on Mathematics Process Competencies.

9c. To find if there is any interaction effect between Training Strategies and Teaching Aptitude on Mathematics Process Competencies.
10a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematical Pedagogical Competencies.

10b. To study whether the prospective mathematics teachers having High Teaching Aptitude and Low Teaching Aptitude differ in mean gain scores on Mathematical Pedagogical Competencies.

10c. To find if there is any interaction effect between Training Strategies and Teaching Aptitude on Mathematical Pedagogical Competencies.

11a. To study whether groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differ in mean gain scores on Mathematics Teaching Competency.

11b. To study whether the prospective mathematics teachers having High Teaching Aptitude and Low Teaching Aptitude differ in mean gain scores on Mathematics Teaching Competency.

11c. To find if there is any interaction effect between Training Strategies and Teaching Aptitude on Mathematics Teaching Competency.

6.8 HYPOTHESES

The hypotheses of the present study were as under:

1.

a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Content Competencies.

b. There exists no significant difference between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematics Content Competencies.

c. There exists no significant interaction between Training Strategies and Achievement Motivation on acquisition of Mathematics Content Competencies by prospective mathematics teachers.
2.
   a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Process Competencies.
   b. There exists no significant difference between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematics Process Competencies.
   c. There exists no significant interaction between Training Strategies and Achievement Motivation on acquisition of Mathematics Process Competencies by prospective mathematics teachers.

3.
   a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematical Pedagogical Competencies.
   b. There exists no significant difference between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematical Pedagogical Competencies.
   c. There exists no significant interaction between Training Strategies and Achievement Motivation on the acquisition of Mathematical Pedagogical Competencies by prospective mathematics teachers.

4.
   a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Teaching Competency.
   b. There exists no significant difference between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematics Teaching Competency.
c. There exists no significant interaction between Training Strategies and Achievement Motivation on the acquisition of Mathematics Teaching Competency by prospective mathematics teachers.

5.

a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Content Competencies.

b. There exists no significant difference between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematics Content Competencies.

c. There exists no significant interaction between Training Strategies and Teaching Aptitude on acquisition of Mathematics Content Competencies by prospective mathematics teachers.

6.

a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Process Competencies.

b. There exists no significant difference between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematics Process Competencies.

c. There exists no significant interaction between Training Strategies and Teaching Aptitude on acquisition of Mathematics Process Competencies by prospective mathematics teachers.

7.

a. There exists no significant difference between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematical Pedagogical Competencies.
b. There exists no significant difference between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematical Pedagogical Competencies.

c. There exists no significant interaction between Training Strategies and Teaching Aptitude on acquisition of Mathematical Pedagogical Competencies by prospective mathematics teachers.

6.9 EXPERIMENTAL DESIGN OF THE STUDY

To study the main effects and interaction effects of the independent variables of Training Strategies, Achievement Motivation and Teaching Aptitude on the dependent variables of Mathematical Exit Competencies, namely, Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies and Mathematics Teaching Competency, of prospective mathematics teachers, statistical technique of analysis of variance was employed. The efforts here were directed to the question, “In what way and to what extent the Training Strategies, Achievement Motivation and Teaching Aptitude with the cross-classification interact in affecting the development of mathematical exit competencies among prospective mathematics teachers”? The answer to this question would have been sought through the factorial design of 2X2X2 analysis of variance. Since, it was an experimental study and nature of the study did not permit to have large sample, it
was not feasible to study second order interaction by including both the classifying variables, namely Achievement Motivation and Teaching Aptitude in one design. Therefore, these two variables were taken one by one. Finally 2X2 factorial design was used twice in the present study.

The variable of Training Strategy was given code A and the two Training Strategies: Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) as A1 and A2 respectively. The variable of Achievement Motivation was given code B and its two levels; low and high as B1 and B2 respectively. The variable Teaching Aptitude was given code C and its two levels; low and high as C1 and C2 respectively. The top 27% cases formed high group and the bottom 27% cases formed the low group.

A layout of factorial design used in the study for variables of Training Strategy and Achievement Motivation is presented in figure 6.1 and for the variables of Training Strategy and Teaching Aptitude is presented in figure 6.2.

**Figure 6.1**

**Shows layout of factorial design for the variables of Training Strategies and Achievement Motivation.**

Total numbers of combinations were $2 \times 2 = 4$. 256
This design was replicated for each of the four Mathematical Exit Competencies, namely, Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies and Mathematics Teaching Competency.

Figure 6.2
Shows layout of factorial design for the variables of Training Strategies and Teaching Aptitude.

A

A1

C1

A1C1

C1

A1C2

C2

A2

C1

A2C1

C2

A2C2

Total numbers of combinations were $2 \times 2 = 4$.

This design was replicated for each of the four Mathematical Exit Competencies, namely, Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies; and Mathematics Teaching Competency.

6.10 SAMPLE OF THE STUDY

The mathematics prospective teachers admitted in various self-financed colleges of education of Punjab affiliated to Punjabi University, Patiala during the session 2008-2009 constituted the population of the study.
The experiment included providing training to group exposed to Mathematics Competency Based Training Strategy (MCBTS) in developing exit competencies in prospective mathematics teachers. Therefore intact sample was chosen through non-probability sampling technique. The sample was divided randomly into experimental group and control group.

A sample of 126 prospective mathematics teachers was taken. The colleges were chosen according to geographical advantage; as the investigator is working in an institution located at district Mohali. The name of the institutions from which sample was chosen were:-

1. Rayat and Bahra College of Education, Sahauran
2. Doaba College of Education, Ghataur
3. Chandigarh College of Education, Landran
4. Guru Nanak Dev College of Education, Majatri
5. Shivalik Institute of Education and Research, Mohali
6. Ambika College of Education, Badala

Out of these six colleges, three colleges, namely, Rayat and Bahra College of Education, Sahauran; Doaba College of Education, Ghataur and Ambika College of Education, Badala were randomly selected and from these three colleges 63 prospective mathematics teachers were randomly selected and were put in group I. Out of the remaining three colleges, namely, Chandigarh College of Education, Landran; Shivalik Institute of Education and Research, Mohali and Guru Nanak Dev College of Education, Majatri, 63 prospective mathematics teachers were randomly selected and were put in group II. One of these two groups was randomly assigned as experiment group (A1) and other as control group (A2). The prospective mathematics teachers from Rayat and Bahra college of Education, Sahauran, Doaba college of Education, Ghataur and Ambika College of Education, Badala constituted the sample for experimental group and the prospective mathematics teachers from Chandigarh college of Education, Landran, Guru Nanak Dev College of Education, Majatri and Shivalik Institute of Education and Research, Mohali constituted the sample for control group.
Experimental group was exposed to Mathematics Competency Based Training Strategy (MCBTS) and control group was exposed to Traditional Training Strategy (TTS).

The justification behind selection of sample was that since students enrolled in the B.Ed course are on the basis of Joint Entrance Test conducted by either of the Universities, namely Punjabi University, Patiala / Panjab University, Chandigarh / Guru Nanak Dev University, Amritsar. Also, the environmental set up and infrastructural facilities of all these self-financing education colleges are almost similar. Accordingly, the investigator assumed that the results of above sample will be true for the entire population.

6.11 TOOLS USED

The tools used in the present study are listed below:

1. Observation schedules developed by the investigator for ascertaining the acquisition of Mathematical Exit Sub-Competencies; according to the set 80/80 criterion level.

2. Rating scales developed by investigator to measure
   - Mathematics Content Competencies
   - Mathematics Process Competencies
   - Mathematical Pedagogical Competencies

3. Mathematics Teaching Competency Assessment Scale (MTCAS) developed by the investigator, was used to assess the Mathematics Teaching Competency of prospective mathematics teachers.


6.12 PROCEDURE OF THE STUDY

A sample of 126 prospective mathematics teachers of the academic session 2008-09 was taken from six self-financed colleges of education affiliated to Punjabi University, Patiala. The sample was divided into two groups as has been already explained while describing the sample. Before implementing the treatment to the two groups, these groups were matched on the variable of Mathematics Teaching Competency (pre-test), Mathematics Content Competencies (pre-test), Mathematics Process Competencies (pre-test), Mathematical Pedagogical Competencies (pre-test), Achievement Motivation and Teaching Aptitude. t-ratios were worked out between the mean scores of group trained through Mathematics Competency Based Training Strategy (MCBTS) and group trained through Traditional Training Strategy (TTS) on these variables. The present study was conducted in three phases:-

PHASE I :- (PRE-TESTING)

In this phase, the initial scores were obtained pertaining to Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies and Mathematics Teaching Competency of prospective mathematics teachers in B.Ed through respective rating scales for Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies and Mathematics Teaching Competency Assessment Scale (MTCAS) for Mathematics Teaching Competency.

Each prospective mathematics teacher included in the sample delivered four macro lessons of 30 minutes to school students. First lesson of each student was observed on rating scale for Mathematics Content Competencies; second lesson was observed on Mathematics Process Competencies; third lesson was observed on rating scale for Mathematical Pedagogical Competencies and fourth lesson was observed on Mathematics Teaching Competency Assessment Scale (MTCAS).

Achievement Motive Test (ACMT) by Bhargava (1994) was administered to get the scores on the Achievement Motivation of prospective mathematics teachers of both the groups.
Teaching Aptitude Scale (TAS) by PSY-COM Services (1996) was administered to get the scores on the Teaching Aptitude of prospective mathematics teachers of both groups.

**PHASE II: - (EXPERIMENTAL PHASE)**

**Treatment to group A1:- (Experimental Group)**

The prospective mathematics teachers of group A1 were given orientation regarding the Mathematics Competency Based Training Strategy (MCBTS) prepared by the investigator. Model lessons were delivered by investigator and discussed. The peers acted as pupils during the training period.

The investigator identified three Mathematical Exit Competencies, namely, Mathematics Content Competencies, Mathematics Process Competencies and Mathematical Pedagogical Competencies.

Firstly, the first Mathematical Exit Competency, ‘Mathematics Content Competencies’ was taken. Under this Mathematical Exit Competency, four Mathematical Exit Sub-Competencies were identified and selected for the study. The first Mathematical Exit Sub-Competency, ‘Mathematics Content Knowledge’ from this domain was taken. Prospective mathematics teachers practiced the competency till the criterion of 80/80 was met. It was followed by the practice of next Mathematical Exit Sub-Competency ‘Illustrating with Examples’ of the Mathematical Exit Competency ‘Mathematics Content Competencies’. It was again practiced till the set criterion of 80/80 was met. The next Mathematical Exit Sub-Competency ‘Selection and Organization of Mathematics Content’ was practiced till the set criterion of 80/80 was met. Further the next Mathematical Exit Sub-Competency ‘Mathematical Connections’ of the Mathematical Exit Competency ‘Mathematics Content Competencies’ was practiced till the mathematics prospective teachers met the criterion of 80/80.

After the practice in all the four Mathematical Exit Sub-Competencies of the first Mathematical Exit Competency ‘Mathematics Content Competencies’, practice
was given in the second Mathematical Exit Competency ‘Mathematics Process Competencies’. The investigator identified and selected four Mathematical Exit Sub-Competencies of Mathematical Exit Competency ‘Mathematics Process Competencies’. The prospective mathematics teachers practiced the first Mathematical Exit Sub-Competency ‘Mathematical Communication’ of this Mathematical Exit Competency. After the set criterion of 80/80 was met, the prospective mathematics teachers started with the practice of next Mathematical Exit Sub-Competency ‘Questioning and Response Management’ of the Mathematical Exit Competency ‘Mathematics Process Competencies’. The practice continued till the set criterion of 80/80 was met. Then the next Mathematical Exit Sub-Competency ‘Mathematical Problem Solving’ was taken and practiced by the prospective mathematics teachers of the experimental group, till the set criterion was met. Further the next Mathematical Exit Sub-Competency ‘Evaluation’ of ‘Mathematics Process Competencies’ was practiced by the prospective mathematics teachers, till the set criterion of 80/80 was met.

Same procedure was repeated with the remaining two Mathematical Exit Sub-Competencies namely, ‘Black Board Writing’ and ‘Multiple Instructional Strategies’, of the third Mathematical Exit Competency ‘Mathematical Pedagogical competencies’. Mathematical Exit Sub-Competencies were practiced in the same way till the acquisition of the set criterion of 80/80.

The training was given in a simulation situation. The investigator herself demonstrated planned model lessons. Relevant observation schedules prepared by the investigator were used. The peers who acted as pupils also provided feedback.

**Treatment to group A2:- (Control Group)**

The prospective mathematics teachers of group A2 were given orientation regarding the Traditional Training Strategy (TTS). Model lessons on five micro teaching skills, namely, Black Board Writing, Introduction of Topic, Illustration with Examples, Questioning, and Explanation; were delivered by investigator one by one and discussed with prospective mathematics teachers of control group.

Firstly, the investigator delivered a model micro lesson on the first micro skill, namely ‘Black board Writing’. Discussions were held in the class. The prospective
mathematics teachers of control group prepared and delivered the micro lesson plan on this particular skill. Peers acted as students of the class. Observation schedule was filled by all the peers. The lesson delivered by the prospective mathematics teacher of the control group was followed by feedback from the peer group. Satisfactory performance led the prospective mathematics teacher of control group to move on to the next skill, whereas the unsatisfactory performance was followed by a re-teach session. The cycle was carried on till the satisfactory performance of the prospective mathematics teacher of the control group.

Then the investigator moved on to the next micro teaching skill, namely, 'Introduction of topic'. The same procedure was followed as explained above.

Same procedure was followed with remaining three micro teaching skills, namely, Illustration with Examples, Questioning and Explanation.

Model lesson on one full topic was given by the investigator. The demonstration was followed by group discussion.

The training to both the groups continued throughout the session. The duration of training was about sixty days and on an average two hours daily for both the groups.

**PHASE III: - POST-TESTING**

In this phase, the final scores were obtained pertaining to Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies of prospective mathematics teachers through respective rating scales and Mathematics Teaching Competency of prospective mathematics teachers through Mathematics Teaching Competency Assessment Scale (MTCAS).

In this phase, the acquisition of Mathematical Exit Competencies by the prospective mathematics teachers was assessed. Each prospective mathematics teacher delivered four macro lessons of 30 minutes to school students. First lesson of each student was observed on rating scale for Mathematics Content Competencies developed by the investigator; second lesson was observed on rating scale for Mathematics Process Competencies developed by the investigator; third lesson was observed on rating scale for Mathematical Pedagogical Competencies developed by the investigator and fourth lesson was observed on Mathematics Teaching...
Competency Assessment Scale (MTCAS) developed by the investigator. The post test scores were then obtained.

The layout of the procedure is given in the table 6.1.

**Table 6.1**

Shows layout of the procedure of the study

Sample (N) = 126 prospective mathematics teachers

<table>
<thead>
<tr>
<th>PHASE</th>
<th>GROUP A1</th>
<th>GROUP A2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHASE I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRE-TEST</td>
<td>1. Rating Scale to measure ‘Mathematics Content Competencies’</td>
<td>1. Rating Scale to measure ‘Mathematics Content Competencies’</td>
</tr>
<tr>
<td></td>
<td>2. Rating Scale to measure ‘Mathematics Process Competencies’</td>
<td>2. Rating Scale to measure ‘Mathematics Process Competencies’</td>
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<tr>
<td></td>
<td>3. Rating Scale to measure ‘Mathematical Pedagogical Competencies’</td>
<td>3. Rating Scale to measure ‘Mathematical Pedagogical Competencies’</td>
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<tr>
<td></td>
<td>4. Mathematics Teaching Competency Assessment Scale (MTCAS) to</td>
<td>4. Mathematics Teaching Competency Assessment Scale (MTCAS) to</td>
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<tr>
<td></td>
<td>measure Mathematics Teaching Competency</td>
<td>measure Mathematics Teaching Competency</td>
</tr>
<tr>
<td></td>
<td>5. Achievement Motive Test (ACMT) by Bhargava (1994) to obtain scores on Achievement Motivation of prospective mathematics teachers</td>
<td>5. Achievement Motive Test (ACMT) by Bhargava (1994) to obtain scores on Achievement Motivation of prospective mathematics teachers</td>
</tr>
<tr>
<td></td>
<td>obtain scores on Teaching Aptitude of prospective mathematics teachers</td>
<td>obtain scores on Teaching Aptitude of prospective mathematics teachers</td>
</tr>
<tr>
<td>PHASE II</td>
<td>Training through Mathematics Competency Based Training Strategy (MCBTS)</td>
<td>Training through Traditional Training Strategy (TTS)</td>
</tr>
<tr>
<td>(Experimental Phase – The Treatment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHASE III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POST-TEST</td>
<td>1. Rating Scale to measure ‘Mathematics Content Competencies’</td>
<td>1. Rating Scale to measure Mathematics Content Competencies’</td>
</tr>
<tr>
<td></td>
<td>2. Rating Scale to measure ‘Mathematics Process Competencies’</td>
<td>2. Rating Scale to measure ‘Mathematics Process Competencies’</td>
</tr>
<tr>
<td></td>
<td>3. Rating Scale to measure ‘Mathematical Pedagogical Competencies’</td>
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</tr>
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<td></td>
<td>4. Mathematics Teaching Competency Assessment Scale (MTCAS) to</td>
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</tr>
<tr>
<td></td>
<td>measure Mathematics Teaching Competency</td>
<td>measure Mathematics Teaching Competency</td>
</tr>
</tbody>
</table>
6.13 COLLECTION OF DATA

The data was collected by following strictly the design and procedure of the experiment. The data consisted of:

1. Pre-test and Post-test scores on Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies and Mathematics Teaching Competency
2. Gain scores pertaining to Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies and Mathematics Teaching Competency
3. Scores on Achievement Motivation
4. Scores on Teaching Aptitude

6.14 STATISTICAL TECHNIQUES USED

Descriptive statistics such as mean, median, standard deviation, skewness and kurtosis were worked out to ascertain the nature of distribution of scores on the variable of four Mathematical Exit Competencies namely, Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies; Mathematics Teaching Competency; Achievement Motivation and Teaching Aptitude.

2x2 analysis of variance was used to study the main effects and interaction effects.

For further investigation, t-test was employed wherever F-ratio was found to be significant.

Inter observer reliability was calculated for rating scales pertaining to three mathematics teaching exit competencies namely ‘Mathematics Content Competencies’, ‘Mathematics Process Competencies’ and ‘Mathematical Pedagogical Competencies’; and Mathematics Teaching Competency.

6.15 FINDINGS AND CONCLUSIONS

In the light of the analysis and interpretation of the results (based upon the empirical evidence), the findings of the study, pertaining to development of
mathematical exit competencies among prospective mathematics teachers are given below:

1. A significant difference was found between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Content Competencies.

2. A significant difference was found between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Process Competencies.

3. A significant difference was found between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematical Pedagogical Competencies.

4. A significant difference was found between groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) in mean gain scores on Mathematics Teaching Competency.

5. A significant difference was found between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematics Content Competencies.

6. A significant difference was found between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematics Process Competencies.

7. A significant difference was found between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematical Pedagogical Competencies.

8. A significant difference was found between High Achievement Motivation group and Low Achievement Motivation group in mean gain scores on Mathematics Teaching Competencies.
9. A significant interaction was found between Training Strategies and Achievement Motivation in mean gain scores on Mathematics Content Competencies.

10. A significant interaction was found between Training Strategies and Achievement Motivation in mean gain scores on Mathematics Process Competencies.

11. A significant interaction was found between Training Strategies and Achievement Motivation in mean gain scores on Mathematical Pedagogical Competencies.

12. A significant interaction was found between Training Strategies and Achievement Motivation in mean gain scores on Mathematics Teaching Competency.

13. A significant difference was found between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematics Content Competencies.

14. A significant difference was found between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematics Process Competencies.

15. A significant difference was found between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematical Pedagogical Competencies.

16. A significant difference was found between High Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematics Teaching Competency.

17. A significant interaction was found between Training Strategies and Teaching Aptitude in mean gain scores on Mathematics Content Competencies.

18. A significant interaction was found between Training Strategies and Teaching Aptitude in mean gain scores on Mathematics Process Competencies.

19. A significant interaction was found between Training Strategies and Teaching Aptitude in mean gain scores on Mathematical Pedagogical Competencies.

20. A significant interaction was found between Training Strategies and Teaching Aptitude in mean gain scores on Mathematics Teaching Competencies.
6.16 SIGNIFICANCE OF THE STUDY

Mathematics is a creative discipline. The language of mathematics is international. The subject transcends cultural boundaries and its importance is universally recognized. Mathematics has developed over time as a means of solving problems and also for its own sake. Mathematics provides a powerful universal language and intellectual toolkit for abstraction, generalization and synthesis. It is the language of science and technology. It enables us to probe the natural universe and to develop new technologies that have helped us to control and master our environment, and change societal expectations and standards of living. (www.dfes.gov.uk/mathsinquiry/) (www.mathsinquiry.org.uk/report)

Mathematical thinking is important for all members of a modern society as a habit of mind for its use in the workplace, business and finance; and for personal decision-making. Mathematics is fundamental to national prosperity in providing tools for understanding science, engineering, technology and economics. It is essential in public decision-making and for participation in the knowledge economy. Mathematics equips pupils with uniquely powerful ways to describe, analyse and change the world. It can stimulate moments of pleasure and wonder for all pupils when they solve a problem for the first time, discover a more elegant solution, or notice hidden connections.

Pupils who are functional in mathematics and financially capable are able to think independently in applied and abstract ways, and can reason, solve problems and assess risk. These expectations from pupils can be fulfilled, when the mathematics teachers acquire / possess certain mathematical competencies prior to completion of their teacher training programs. Therefore, the results of the present study can be of great significance to prospective mathematics teachers, mathematics teachers, curriculum planners of teacher education, mathematics teacher training program and recruitment policy for mathematics teachers. So the points highlighting the significance of the present study are as under:

- Groups trained through Mathematics Competency Based Training Strategy (MCBTS) and Traditional Training Strategy (TTS) differed significantly on the variables of Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics
Teaching Competency. This result is indicative of the fact that Mathematics Competency Based Training Strategy (MCBTS) is more effective in acquisition of mathematical exit competencies.

Competency based education is outcome based instruction and is adaptive to the changing needs of mathematics students, mathematics teachers and the community. Mathematical competencies describe the student’s ability to apply basic mathematical skills in situations that are commonly encountered in everyday life. Consequently, Mathematics Competency Based Training Strategy (MCBTS) is based on a set of outcomes that are derived from analysis of tasks typically required of students in life role situations and correspondingly, the roles of a mathematics teacher in a present day 21st century classroom situation. Therefore, such strategies should be implemented in teacher education colleges in order to develop subject (mathematics) based exit competencies along with general teaching competencies. This will make novice mathematics teachers capable of facing a mathematics classroom situation in a ground-breaking mode.

The curriculum of teacher training institutions cannot be changed / reviewed at institutional level. But the head of the institute can plan activities during teaching practice in such a manner that rating scales and observation schedules developed in Mathematics Competency Based Training Strategy (MCBTS) can be utilized in developing mathematical exit competencies among prospective mathematics teachers. The point to point feedback provided to the prospective mathematics teachers on the basis of filled observation schedules and rating scales will develop an overview of the desired performances from prospective mathematics teachers.

- High Achievement Motivation group and Low Achievement Motivation group differed significantly on the variables of Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics Teaching Competency. The finding highlights that prospective mathematics teachers with High Achievement Motivation demonstrated superior competence in acquisition of mathematical exit competencies as compared to prospective mathematics teachers with Low
Achievement Motivation. The finding poses a serious question on mathematics teachers with Low Achievement Motivation. Such teachers would easily slip back to old traditional methods / strategies of teaching mathematics, thereby making a mathematics classroom dull and boring. Therefore, a special attention should be paid to prospective mathematics teachers with Low Achievement Motivation. They should be provided extra guidance and time for developing competence in teaching mathematics through orientation courses / refresher courses / workshops. Attempts should be made to increase their motivational levels and their need for achievement. Moreover, while appointing mathematics teachers in schools, their achievement motivation should be measured and refresher courses / specialized programs should be planned accordingly.

- Training Strategies and Achievement Motivation interacted significantly on the variable of Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics Teaching Competency. Teacher educators can gain insight form these interactive processes of Training Strategies and Achievement Motivation on acquisition of Mathematical Exit Competencies, namely, Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics Teaching Competency; and, make use of this insight while giving training to prospective mathematics teachers.

- High Teaching Aptitude group and Low Teaching Aptitude group differed significantly on the variable of Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics Teaching Competency. This result is indicative of the fact that prospective mathematics teachers with High Teaching Aptitude were superior in acquisition of mathematical exit competencies as compared to prospective mathematics teachers with Low Teaching Aptitude. Therefore, efforts should be made by mathematics teacher training institutes to design various training programs for mathematics
teachers with varying Teaching Aptitudes. It would develop qualities, such as in-depth understanding of mathematics content, open mindedness, communication in mathematical terms, mathematical problem solving, evaluation, use of various instructional strategies, making mathematical connections, etc. and have some basic knowledge about ways of creating effective mathematics teaching learning process in a classroom.

- Training Strategies and Teaching Aptitude interact to produce significant effect on the variable of Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics Teaching Competency. Teacher educators can develop some perceptivity from the interactive process of Training Strategies and Teaching Aptitude on acquisition of Mathematical Exit Competencies, namely, Mathematics Content Competencies, Mathematics Process Competencies, Mathematical Pedagogical Competencies, and Mathematics Teaching Competency; and can accordingly plan the Training Strategies for the prospective mathematics teachers.

- Mathematics Teaching Competency should be recognized as an essential exit competency to be acquired by prospective mathematics teachers before entering into the profession. The acquisition will make a beginner mathematics teacher competent of making his/her teaching more effective.

- Also, the Mathematics Teaching Competency Assessment Scale (MTCAS) developed by the investigator can be utilized by the school authorities as recruitment criteria for mathematics teachers.

Thus the findings of the present study can open new vistas of mathematical exit competencies for prospective mathematics teachers / mathematics teachers, teacher education curriculum planners and teacher educators and their head of the institutes. The findings will be helpful in dealing with abstract nature of mathematics which usually hinders active pupil participation in mathematics classroom. This study can be helpful in revival and re-vamping of mathematics teacher training program which needs to be modified to suit to present content and national interest.
6.17 SUGGESTIONS FOR FURTHER RESEARCH

The areas in which further research work can be conducted are as follows.

1. A similar study may be conducted by including other five listed mathematical exit competencies, namely, Writing Instructional Objectives, Mathematical Representations, Reasoning and Proving, Critical Thinking, and Pedagogical Knowledge competency, which were not included in the present study due to shortage of time.

2. An experimental study may be conducted to increase the use of alternative assessment methods like rubrics, activity sheets, open ended questionnaires, etc.

3. Study may be undertaken to identify more mathematical exit competencies for mathematics teachers. Further an experimental study may be conducted by incorporating these competencies in the training strategy.

4. The study may also be conducted by taking more sub-competencies under different mathematical exit competencies.

5. Effectiveness of Mathematics Competency Based Training Strategy (MCBTS) in relation to other variables like attitude towards teaching profession, self esteem, mathematical creativity, etc may be studied.

6. A study of similar nature can be undertaken for special education teachers.

7. Study may be replicated on a larger sample.

8. Similar studies may be conducted in various disciplines.

9. Study may be replicated in other teacher training institutions.

10. A follow-up study may be conducted to investigate whether the strategy is helpful in retaining the acquisition of mathematical exit competencies after an appropriate interval of time.