Chapter II

Review of Related Literature
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“Double Discontinuity”, the term as introduced by Felix Klein (1933), is a major challenge confronting our teacher training program. At the beginning of his teacher education, a young student / prospective teacher of mathematics faces problems which does not remind him at all on what he has worked on when he was at school; of course he forgets those things quickly and completely, but, if then, after he has passed his exams, the individual starts working as a teacher, he is expected to teach exactly the elementary mathematics in a manner adequate to the school system. As he i.e. the pupil teacher is nearly unable to connect the elementary mathematics to his university mathematics, in most cases, he will soon come back to the old-fashioned teaching traditions and his university education remains more or less a romantic memory which has no impact on his teaching. Knowing mathematics does not ensure the effectiveness of prospective teachers. How they come to know their mathematics matters as well.

During the past decade, teaching concepts in the field of higher education have been in a state of transition. The dominance of ‘knowledge-transmission’ paradigm has decreased in favour of new paradigms such as, ‘process- transmission’, ‘skill-transmission’ or ‘performance- transmission paradigm. This transition has triggered various reforms in many institutes of higher education. The need is 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’. Since the future work situations that today’s students will be dealing with cannot be prescribed, students need to learn in ways which develop their capacity to discern the relevant aspects of relatively novel situations. It is suggested that this is best achieved by including contextual variation as part of the learning experience. As Marton (in press) states: "In order to become capable of dealing with a varying future we must have met a varying past". A variety of approaches should be employed in transmitting the didactics to prospective teachers.
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. The notion of competency-based education programmes was first introduced in the USA, beginning in teacher education in the late 1960s, and evolved through applications to other professional education programmes in the USA and India in the 1970s, vocational training programmes in the UK and Germany among others in the 1980s and vocational training and professional skills recognition in Australia in the 1990s.

Various investigators have conducted researches in the field of competency-based teacher education. A brief review of related studies is discussed under following headings:-

- Studies related to Competency Based Education
- Studies related to Assessment of Exit Competencies
- Studies related to Exist Teaching Competencies in Mathematics
- Studies related to Achievement Motivation
- Studies related to Teaching Aptitude

2.1 STUDIES RELATED TO COMPETENCY BASED EDUCATION

Norton (1987) believes that competency based training should be used as opposed to “Medieval concept of time based learning”. He also believed that participants in a competency-based training course should learn in an environment that duplicates or simulates the work place. He defined five essential elements of competency-based training—competencies, criterion-referenced evaluation, provision for individual development and evaluation, requirement of student performance, and student-paced instruction. Facilitating or supporting characteristics were listed; these were grouped into instructional and administrative characteristics. Focus of the study was then shifted to identification of training program needs. A suggested comprehensive vocational education program planning model was presented. Three steps were discussed in detail: assessing individual needs and interests (including student vocational and educational interests, student needs,
student abilities, and adult training and retraining needs), assessing labor market needs, and analyzing and synthesizing existing programs and services. A discussion of development of competency-based instructional materials was followed by information on occupational skill competency-testing, available test products and services, and test selection. He presented CBE student-evaluation model, more specific information on program planning, a reference guide to writing student learning guides, and a CBE program evaluation checklist.

Foyster (1990) argued that using the traditional “school” model for training is inefficient and that assessment in competency-based programs must be criterion-referenced with the criterion being the competencies upon which the program is based. He suggests that to assess competence, one first has to develop performance criteria, determine assessment criteria and then gather performance evidence. At that point one can then make judgements about competence. Foyster suggests that a useful statement about the nature of ‘competence’ must provide evidence about three elements, that is: details of the range of skills performed within the competence, which include both routine (skills based) and non-routine (ability to be flexible in a work environment); standards of performance in terms of production rate, error rate and level of quality; and conditions under which performance is required.

Miller (1990), described a four stage hierarchy of competencies, starting with "knowledge," progressing through "know how" and "show how" (competence), and culminating in "does" (performance). Performance depends on the context in which a doctor works as well as his or her abilities. He presented a triangle of clinical competence.

Figure: 2.1 Showing assessment of prescribing at medical schools, surveyed across England, described using Miller's (1990) triangle of clinical competence.
According to a study of basic skills education programs in business and industry, Delker (1990) found that successful training programs were competency-based and that the best approach for training involved learner-centered instruction using print, instructional technology and simulations. The use of more humane teaching methods is an important factor in improving the quality of skills training. This Contractor Report was prepared as background information for Office of Technology's assessment: "Worker Training: Competing in the New International Economy." A review of workplace basic skills research and practice identified factors contributing to success. The review of the research defined workplace basic skills and found that: (1) there was a scant relationship between academic basic skill competence and job performance; and (2) requirements for job-related basic skills were best addressed in competency-based training programs. Eight field investigations were conducted to view current job-related basic skills programs. Programs studied were as follows: Plumley Companies; Aetna Institute for Corporate Education; South Carolina’s Governor’s Initiative for Work Force Excellence; Connecticut’s State Education Department; New York’s Employer Specific Skills Training Program; Houston Community College; Rockingham Community College; and Skills (2000). These programs were examined in terms of a figure with two axes—one representing a purely academic approach to basic skills designed to make the learner proficient in academic settings, another representing a purely job-related basic skills approach designed to make the worker proficient in quite specific workplace settings. The programs were found to illustrate the importance of four types of support: employer support, union support, state support, and federal support. Two major categories of interactive factors contributing to success or failure were identified in two major categories: learning system factors and support system factors.

Collins (1993) objected that “100 years of educational, psychological, organizational, and cultural research has largely been ignored”. In particular, the behaviorist conception of “skill” and “competence” as individual and value free is contradicted by recent research suggesting that skills are social constructions or cultural practices (Collins, 1993; Harris et al, 1995).

Jackson (1993) stated that because of the complexity and indeterminate nature of real world situations, “behavioral objectives can never be achieved in practice with
the precision they offer in theory”. Instead, studies of the development of expertise as well as the constructivist view of learning suggest that people make judgements and review, reflect on and change behavior, continually reconstructing relevant and useful knowledge as they interact with a situation (Hyland, 1994; Hodkinson and Issitt, 1995).

Erridge and Perry (1994) stated that competency-based education and training gives individuals opportunities to “achieve qualifications that relate to required performance in the workplace” and consequently satisfies employer’s needs for a skilled workforce.

Khantachvana (1994) conducted a survey study on technical teachers. The instrument used in this study categorized desired competencies in the following areas: knowledge, cognitive skills, experimental skills, attitude and teaching skills. The study found that all the competence categories were perceived by technical teachers to be of “high importance”.

Yoo (1994) in his study investigated the definition, population served and teacher competence regarding transition services from the school to work reported by faculty members of special education. It suggested that teacher training programs and educational policy development need to include the teacher competencies and the definition of transition service which relate to interdisciplinary function, collaboration and interpersonal communication skills. The most highly ranked competency was, “clearly articulate to prospective employers accurate and realistic client information and expectations”. The competencies and domains which were most highly ranked were based on the interdisciplinary function, collaboration and interpersonal communication skills with persons in the related fields.

Reddy (1994) identified and validated computer information competencies which would enable a graduate from community college to perform satisfactorily in an entry-level job in three occupational areas of operational programming and networking. The study indicated an overwhelming similarity in the mean ratings of the identified competencies in operations, programming and networking needed for entry-level positions for graduates of a Computer Information System (CIS) program in a two year college. These mean ratings should prove valuable for job description in industry and curriculum development in education.
Kemmer (1994) conducted a study to identify professional competencies which are considered most important and least important by superintendents and board members, and how these perceptions differed according to pupil enrollment. Both superintendents and board members selected “Accomplish goal” set by board as number 1 competency which would most likely cause dismissal or non-renewal. However there was a significant difference in the perception regarding the importance of “Supdt./Bd. Relations” as superintendents ranked this competency higher. Also, while large and medium sized districts perceived “Accomplish goals set by Board” as number 1 competency, small-sized districts ranked “Personnel Management” as the top competency. Finally large sized districts placed more importance upon collective bargaining / meet and less importance upon “curriculum development”.

Thach (1994) identified the roles, outputs and competencies of distance learning professionals within the United States and Canada. A competency model for distance learning was developed. The model illustrates the final top ten competencies which portray the dual importance of both communication and technical skills in distance learning. These ten competencies are: interpersonal communication, planning, collaboration of team work, English proficiency, writing, organizational, feedback, knowledge of distance learning fields, basic technology knowledge and technology access knowledge.

Bunch (1994) explored the written discourse development of four doctoral students in a mathematics education program at a research university. The study revealed that these students needed twelve competencies in order to become proficient writers of their professional discourse. In what was roughly a development, though not strictly linear sequence, they had learned the language of the discipline, develop content knowledge, accept the community’s values, acknowledge the conversational nature of the discourse, adopt a critical stance, develop a researcher’s perspective, learn to collaborate, find an acceptable topic, learn the community’s assumptions, learn the discourse general conventions, develop heuristic purpose of audience and develop an autonomous voice.

Harris et al. (1995) promoted competency-based education and training as a way to improve correspondence between education/training and work place requirements. They argued that competency-based education and training is
individualized, emphasizes outcomes (what individuals know and can do), and allow flexible pathways, for achieving outcomes. It makes as clear as possible what is to be achieved and the standards for measuring achievement.

JHPIEGO (1995), an affiliate of Johns Hopkins University and a non profit organization dedicated to improving the health of women and families globally, has adopted a competency-based approach to conducting clinical training in selected reproductive health practices. According to Sullivan (1995), JHPIEGO’s approach to competency-based training involves key activities during the design, delivery, and evaluation of training courses. The key features of JHPIEGO’s approach to training included: development of competencies, quality of performance, development of qualified providers, and building competency and confidence because participants know what level of performance is expected, how knowledge and skills will be evaluated, that progression through training is self paced and that there are opportunities for practice until mastery is achieved.

According to Jones and Moore (1995), although behaviourism is only one competency based approach, it has been the most promoted and influential in part because it is easier to specify task-based behaviours than identify and describe underlying attributes (Harris et al, 1995).

However, Hager (1995) suggested that competency-based education and training has accommodated different conceptions of competence. One of these involves the inclusion of generic attributes underlying competent performance (such as knowledge and understanding).

Granneman and Conn (1996) conducted a study on an evaluation of the effectiveness of competency-based code blue education in USA. Two types of mock code programs were compared. The specific factors investigated were nurse satisfaction, comfort, and retention of knowledge and skills. A sample of 48 nurses initially participated in the mock code program, with 45 nurses participating in the 6-month follow-up evaluation. The study revealed that competency-based and group code blue programs resulted in similar levels of satisfaction, knowledge, and rate of performance of critical elements 6 months after the initial program.
Hyland (1994) and Chappell (1996) considered this approach to be excessively reductionist, narrow, rigid, atomized and theoretically, empirically and pedagogically unsound. They argued that the approach is conceptually confused, empirically flawed and inadequate for the needs of learning society.

Hyland (1994); Gonczi(1997) highlighted that behaviorist framework breaks down competence into the performance of discrete tasks, identified by functional analysis of work roles. This analysis is the basis for competency statements or standards upon which competence is assessed and toward achievement of which Competency Based Education and Training is directed. Behaviorism is criticized for ignoring the connections between tasks; the attributes that underlie performance; the meaning, intention, or disposition to act; the context of performance; and the effect of interpersonal and ethical aspects.

Leung (2000), a medical professional, casts doubt on the value of the competency based approach. He takes a narrow view, dismissing work which develops the concept to reflect the complexity of professional practice. Leung ignores evidence and consensus that knowledge driven traditional models of professional training fail to meet the demands of daily practice. "Competency" describes what a doctor should be capable of doing, and Leung is correct that education focused entirely on narrow definitions of competencies has limitations for professionals. Reflective practice is ignored by reducing professional practice to an exhaustive list of competencies.

The Human Employment and Resource Training (HEART, 2000) Trust/National Training Agency of Jamaica applied the competency-based approach in the design, delivery and assessment of its training programs. They emphasized that major aim of competency-based training is the development of a competent workforce. The HEART Trust curriculums placed a strong emphasis on performance based assessment.

As result of global move to competencies, two major projects, the De SeCo (Rychen,2002) and Tuning projects (González and Wagenaar, 2003) , have been undertaken in Europe. Both of these projects, and in particular, the tuning Project, aim to reform higher education in European and subsequently around the globe (González and Wagenaar, 2003). In other words, higher education is
going through a vigorous global reform. The 'Tuning Project' in Europe, that has been carried out since 2001 by 100 universities and coordinated by the University of Deusto (Spain) and the University of Groningen (The Netherlands) and supported by the European Commission, focuses on educational structures and contents studies of Higher Education (Gonzalez and Wagenaar, 2003). The impact and consequences of these reforms on the higher education globally lead to tuning of curricula in terms of structures, programs and, in particular, actual teaching of competencies (Gonzalez and Wagenaar, 2003).

Tuning Project emphasises that not only academic and professional profile required by the society are important in this process, but also equally important is “the expression of the level of education to be achieved in terms of competencies and learning outcomes” (Gonzalez and Wagenaar 2003). While the DeSeCo project emphasizes the significance of general competencies at the global level, the Tuning Project addresses both discipline specific and generic knowledge competencies. Both projects involve competencies and Competency Based Training that have created misunderstandings and confusions of various kinds round the world. For example confusions about competency and competency based training has been identified by some research works to be either conceptual (Rychen, 2002; Reeff, 2003), pedagogical (Chappell, 2003; Schofield & Mc Donald, 2004) or methodological / theoretical (VieyraKing, 1996; Hinzen, 2001).

The global move to Competency Based Training has introduced a number of new concepts and chief among these concepts is the concept of competence (Mansfield, 2004). The concept has created confusions and a host of conceptual misunderstandings at global (Van and Semeijn, 2001; Mansfield, 2004), national (Smith and Keating, 2003; Schofield and McDonald, 2004; Mitchell, Chappell, Bateman, and Roy, 2005; Azemikhah, 2005) and State (Robinson and Misko, 2003) levels.

Al-Sayyed (2005) constructed a training program based on educational competencies for prevocational education teachers (PET) in the basic education cycle, and an assessment of its effectiveness in improving these competencies. The results of the three-way ANOVA and t-test analysis revealed that there were significant
Hoogveld, et al., (2005) conducted a study to determine the differential effects on the design of learning tasks for Competency-Based Teacher Education (CBTE) of a teacher training with a classical approach. The result shows that the classic condition performed significantly better than the alternative condition. Patel and Khamis (2005) presented an augmentative and alternative communication (AAC). The training program was given to 20 special education teachers in a Palestinian Arab society in Israel. The training program contained of educational workshops interleaved with on-site supervision. Instructional aims integrated creating awareness, imparting knowledge, and assisting teachers to increase and use AAC within their classrooms. Teachers' responses revealed that training program helped them to address barriers to AAC intervention.

Al-Ajloni (2006) conducted a study that was aimed at constructing a training program for developing vocational competencies for trainers of vocational Training Corporation. The results revealed that the training program was high 4.62 out of 5, and it could be adopted according to the specialist's perspectives as a training program for vocational trainers in Jordan.

Al-Khatib (2007) evaluated the impact of a training program on Jordanian classroom teachers' knowledge of the characteristics and needs of students with learning disabilities. The study also investigated whether such training influenced teachers' acceptance of including these students into their classroom. 60 teachers were divided into two equal groups with 30 teachers in each. One group was randomly chosen to be experimental and the other as the control group. Two instruments were developed to assess teachers' knowledge of learning disabilities and a survey of teacher acceptance of inclusion of students with learning disabilities. These instruments were applied to the two groups as pretest and posttest. The researcher constructed a training program based on increasing teachers' knowledge of the characteristics and needs of students with learning disabilities. This program consisted of five training units. The experimental group was enrolled into the training program for 6- weeks. The results revealed that the training program had significant effects on
both teachers' knowledge of the characteristics and needs of students with learning disabilities and their acceptance of including these students into their classroom.

Ismail, Al-Zoubi, Rahman and Al-Shabatat (2009) measured the effect of a training module in improving knowledge competencies for resource room teachers in Jordan. The training module consisted of 10 training sessions, covered three domains, namely, planning, instruction and classroom management, and evaluation competencies. The sample of the study consisted of 50 teachers. The participants of the sample were distributed into two equal groups, with 25 teachers in each group. The teachers in the experimental group were attached with the training module for five weeks; whereas the teachers in the control group were exposed for the same period to the conventional training adopted by the Ministry of Education in Jordan. The results of (ANCOVA) revealed that there were statistically significant differences between the means of the two groups, means on the post-achievement test, favoring to the experimental group. Furthermore, results of the experimental group on the achievement test revealed no statistically significant differences across the demographic variables, namely, gender, specialization, qualification, and experience.

Colt, et al. (2010) conducted a study on Use of Competency-Based Metrics to Determine Effectiveness of a Postgraduate Thoracoscopy Course. The Objectives of the study were to assess the use of a single-group, pre-/post-test model comprised of multiple-choice questions (MCQ) and psychomotor skill measures to ascertain the effectiveness of a postgraduate thoracoscopy program. A 37-item MCQ test of cognitive knowledge was administered to 17 chest physicians before and after a 2-day continued medical education-approved program. Pre- and post-course technical skills were assessed using rigid video thoracoscopy simulation stations. Competency-based metrics (mean relative gain, mean absolute gain, and class-average normalized gain \(<g>\)) were calculated. A \(<g> >30\%\) was used to determine curricular effectiveness. Results: Mean cognitive knowledge score improved significantly from 20.9 to 28.7 (7.8 ± 1.3 points, \(p < 0.001\)), representing a relative gain of 37% and an absolute gain of 21%. Mean technical skill score improved significantly from 5.20 to 7.82 (2.62 ± 0.33 points, \(p < 0.001\)), representing a relative gain of 50% and an absolute gain of 33%. Non-parametric testing confirmed t-test results \((p < 0.001)\). Class-average normalized gains were 48 and 92%, respectively. The Conclusion of the study was that the Competency-based metrics, including class-average normalized gain, can be
used to assess course effectiveness and to determine if a program meets pre-
designated objectives of knowledge acquisition and psychomotor technical skill.

Competency-based education has been one of the widely explored areas. Most
of the investigators approved competency-based approach and opposed traditional
approach (Norton, 1987; Foyster, 1990; Harris et al., 1995; Watson, 1990; Erridge
and Perry, 1994), but at the same time some argued against this approach (Chappell,

The trend is inconclusive. On one hand, competency-based education is said to
be individualized, emphasizes outcome (what individuals know and can do), and
allows flexible pathways for achieving the outcomes, and on the other hand it is
opposed as it attempts to achieve individualization in education, each student is
expected to display the same competencies. To the extent that competency is defined
as a minimum level of performance, there is little incentive for the individual students
to strive for excellence. The conflicting findings of the past investigations make it
desirable to study the effectiveness of application of competency-based approach.
Still there is need of exploration in this field. Moreover this approach is now widely
acclaimed in different professions like industry, business and medical field. Extensive
research needs to be done in the field of application of competency-based approach
for teacher education.

2.2 STUDIES RELATED TO ASSESSMENT OF EXIT
COMPETENCIES

Assessment has always been an important component of any educational
reform. In recent years educators have emphasized the importance of alternative
assessments, particularly performance and portfolio-based assessments in the
classrooms (Holmes Group, 1986; Haertel, 1991; Wolf et al, 1991; Danielson and
Marquez, 1998; Hargreaves, Earl and Schmidt, 2002).

Wilson (1982) reported on a research study conducted by the Victorian
Institute of Secondary Education during 1980-81. The purpose of the study was to
explore the issue of school-based assessment as it pertained to Victorian employers,
within the context of recruitment processes, certification and school reporting
procedures. Ninety employers within Government and non-Government
organisations, 75 from the Melbourne metropolitan area, and 15 from a selected
country area, were surveyed by means of structured interviews. Sixty per cent of employers reported that they always looked at educational records when employing young people; 35% reported they occasionally looked at educational records; and 5% did not use them at all. Forty-nine per cent of employers reported that they had found school reports helpful; 34% that they were of little help; and 17% that they did not help. Concerns expressed were that school reports varied from school to school; for example, grading systems and subject titles which made it difficult for them to ascertain the level of achievement, and which could result in unfairness to applicants. Sixty-two per cent were in favour of changes to current methods of school reporting.

Anderson et al (1981) concluded from the findings that:

'if methods of assessment and reporting can be developed to provide more useful and appropriate information about young people’s education and performance, then this should facilitate and improve the recruitment of school leavers into positions that are available’.

In the Wilson (1982) study, employers were shown three examples of certificates reporting school-based assessments. The most preferred (89%) certificate was one containing grades and descriptive items. Much less preferred was the certificate containing grades only (8%) and the certificate that contained descriptive statements and a satisfactory or unsatisfactory grading statement (3%). The findings indicated that at the time of the study, the majority of employers preferred to see both achievement levels and additional comments.

As one employer commented:

The descriptive statement is very helpful to the employer in identifying the skills that an employer may be looking for... so that even if a student's achievement is not high, an employer can see he [she] has the appropriate job skills. (Wilson, 1982).

Darling-Hammond,(1986); Shulman, (1986); Haertel, (1991); Darling-Hammond and Snyder, (2000) have criticized the teacher assessments for their inability to measure essential teaching skills, with their main focus on inability to assess pedagogical content knowledge. They argued that teachers cannot be judged by a test that has a single right answer, because teaching is a complex activity, teacher assessment should be more open minded to provide information about candidate’s decision taking capabilities.
Teachers ability to connect content knowledge to lessons and instructional strategies has been a focus for many educators including Shulman (1986, 1987) who termed this knowledge pedagogical content knowledge. For Shulman (1986) pedagogical content knowledge includes “the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations”.

Thomson & Pearce's (1990) research findings illustrated a need for training of on-the-job assessors, because they have had little preparation for this new and complicated role they have acquired in competency – based approach. As a result, they (the untrained teachers) tend to carry out little or no testing, to confine their tests to attitudinal skills, and to have limited appreciation of the difficulties and pitfalls inherent in the assessment of attitudes. Foyster (1990) agreed with these research findings, and added that industry should be involved in the assessment process.

Foyster (1990) argued that assessment in competency-based programs must be criterion-referenced with the criterion being the competencies upon which the program is based. The study consisted of a description of competency-based training (CBT) and assessment and a short test of readers' CBT understanding. He listed five major steps in the development of CBT programs, and explained that CBT’s superiority over traditional methods in bringing employees' skills to required levels is what accounts for its frequent adaptation. The five steps in CBT development were:- skill identification, organization of the skills into appropriate groups from which learning activities can be developed, development of the physical materials upon which the training program will be based, staff development, and detailed recordkeeping. The second section defined competence and applied the definition. The third section described competency-based training programs, including desirable characteristics of such programs. The fourth section addressed the issues surrounding testing for competency, including why it should be done, gathering evidence, articulating standards, the validity and reliability of standards, cost-effectiveness, methods of assessing, recordkeeping, and maintaining standards. The fifth section considered the implications of CBT for employers, teachers, and learners. A short test of readers' understanding of CBT, 27 annotated references, and the answers to the test concluded the document.
Reynolds (1992) stated that, determining whether or not teachers competent to teach is not an easy task. She argued that a valid teacher assessment cannot be developed without first finding what beginning teachers are expected to do in their classrooms. Based on reviews of research conducted by various researchers and organizations she concluded the following:

*Competent teachers create lessons that enable students to connect what they know to new information. In order to create good lessons, teachers must know their subject matter in a way that enables them to explain it to students.*

*Teachers must also know their students in ways that allow them to tailor subject matter, curricular materials, and instructional activities to students.*

Barrie and Pace (1997) stated that “the validity of measurement techniques associated with the behavioural model of learning are indicators of significant learning”. In particular, the “checklist” approach, in which a competency is achieved/not achieved or a person can/cannot perform a particular task is considered simplistic and demotivating, suggesting a “minimum” level of acceptable performance rather than a standard of excellence.

National Council for Accreditation of Teacher Education (NCATE), United States, has argued for performance and competency-based assessments in terms of institutionalizing assessment reform in teacher education (NCATE, 2002). NCATE believes that colleges, particularly departments of education should “ensure that new teachers attain the necessary content, pedagogical and professional knowledge and skills to teach both independently and collaboratively”.

Flowers and Hancock (2003) developed an interview protocol to measure teacher performance, which focused on how well the teachers were able to impact student learning by modifying their instruction. Many educators now believe that performance assessments are useful to assess knowledge and skills which are not generally captured by traditional assessment techniques such as multiple choice or essay examinations (Swanson et al., 1995; Khattri, Reeve & Kane, 1998; Bommer & Rubin, 2000; Parke, 2001). Other researchers suggest that performance-based assessments can be used as tools for instructional changes in school (La Parke & Stone, 2002; Vogler, 2002). Thomson (1991) reported that decision...
recognize a performance as satisfactory and determine competence should be the basis of a competency-based program.

Along with NCATE, many educators and teacher preparation institutions are eager to measure teacher competencies (Flowers and Hancock (2003); Reynolds (1992); Vogler (2002)). There are two viewpoints on validity and reliability as applied to performance-based assessment. On the one hand, Messick (1994) argues that, as in all other forms of assessment, reliability and validity must be addressed in performance-based assessment. Crehan and Hudson (2001) emphasize the importance of establishing inter-rater reliability in performance assessments. On the other side researchers argue that because performance-based assessments are open-ended, it is not possible to maintain their replicability and generalizability in the traditional sense (Haertel (1991); Delandshere & Petrosky (1994); Moss (1994)). Moss argues that inconsistency in rating student’s responses does not necessarily invalidate the assessment task. These researchers emphasize the interpretive nature of consistency and validity within the given context and situation.

Koirala, Davis and Johnson, (2008) conducted a study on Development of a Performance Assessment Task and Rubric to Measure Prospective Secondary School Mathematics Teachers' Pedagogical Content Knowledge and Skills. The purpose of this study was to share a performance assessment task and rubric designed to assess secondary school mathematics pre-service teachers' pedagogical content knowledge and skills. The assessment task and rubric were developed in collaboration with five education faculty, four arts and sciences faculty, and four high school teachers over a period of one year. Over this period, the group met more than fifteen times and designed an assessment task and rubric to measure secondary school pre-service teachers' pedagogical content knowledge and skills. The assessment task and rubric were piloted at the end of the year and extensively revised using the pilot data. The redesigned task and rubric were successfully carried out in the second and subsequent years. Other teacher education programs can benefit from this assessment of teacher candidates' pedagogical content knowledge and skills.

Alnoor and Yu (2010) conducted a study on Yemenis Primary School Teacher Competency. The professional competences of primary schools mathematics teachers have been identified. Also the significance of extent of such competences for Yemenis mathematics teachers have been studied. The researcher used descriptive
research approach. The study data collected from specialist educators and teachers experts to determine the mathematics teaching competences. To know how the mathematics teachers apply those competences, the researcher distributed a questionnaire to 62 Yemenis teachers in primary schools after testing the validity and computing its reliability through Pearson Correlation Coefficient which was 92.32%. The study created a list of necessary competences for mathematics teachers and distinguished teacher’s point of view on the competencies significance.

Nooprick (2010) conducted a study on Development of an Assessment System in Mathematics Instruction for Seventh Grade Students. The major objective of this study was to develop of an assessment system in mathematics instruction for seventh grade students. There were four major purposes namely, the need assessment, the development of the system, try out and the evaluation of the system. The research sample consisted of 4 mathematics teachers and 249 students. The research comparison group consisted of 6 mathematics teacher and 285 students. The data collection includes documentary research, interview, classroom observation and testing. The analysis of the obtained data is performed quantitatively via descriptive statistics and qualitatively via content analysis. The research findings are as follows:

- The need assessment of the launched scheme shows that all math teachers and students need to assessment system mathematics instruction.
- The aforementioned system comprises 3 principal components, namely curriculum development system: CDS; the instructional and assessment system (Understanding by design: UbD) and the feedback system and monitoring.
- The tryout of the evaluating reveals that teachers of sampled can put this system into practical use assessment for learning and provide favorable feedback on mathematics instruction to develop their students as well as their own implementation. Hence, these student achieve substantial progress in the system-yielded results, thereby creating their teachers good desired outgrowths upon the operated program.
- The evaluation of the launched scheme shows that all the participants are satisfied with it, sharing an opinion in that the generated system contains utility, feasibility, propriety and accuracy. Furthermore, system users were satisfied with this Methodology.
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.

2.3 STUDIES RELATED TO EXIT TEACHING COMPETENCIES IN MATHEMATICS

Mayer & Greeno (1972) in one controlled study taught college students the concept of binomial probability. Some students were taught using the inductive method, while others were taught using the deductive method. Both groups received the same basic information and same computational examples -- only the sequence varied. Both groups were then given a test that contained four types of problems:

1) Ones those were just like those given in the examples;
2) Ones that were slightly modified from the example problems;
3) Ones those were unanswerable;
4) Ones that asked questions about how and when to use the formula.

Results of the study indicated that while the deductive group did better on problems that were just like the examples, students in the inductive group did better on the other three types of questions. They were able to apply their knowledge to new situations.

Hamlett (1978) from Edith Cowan University, Perth, Western Australia presented a paper on "Mathematics content knowledge of pre-service Primary teachers: developing confidence and Competence". This paper examines the extent to which a group of first year pre-service teachers enrolled in Bachelor of Education courses in primary and early childhood education at a Western Australian (WA) university can be considered as mathematically literate when it comes to teaching the
content of the WA primary mathematics curriculum, and describes how both confidence and competence have been improved through the introduction of a multiliteracy unit. He concluded that Students entering teacher education courses at this university demonstrate low levels of mathematical competence relative to the expectations of Level Four of the Outcomes and Standards Framework Mathematics (the benchmark for year nine students in the state). In addition, they lack confidence in their own ability to answer the questions presented to them. The change in attitude towards mathematics which is achieved by offering a variety of learning materials which are individualised, non-threatening and even fun, demonstrates the value of engaging students in their own learning and giving them responsibility for addressing their individual areas of weaknesses.

Begle (1979) concluded that subject matter was irrelevant, especially in a subject like mathematics. For this study, college mathematics training, as measured by courses taken, was used as a proxy for teacher’s mathematical knowledge. The correlation of this with student achievement was found to be slightly negative. A similar but less specific method was used in the Third International Mathematics and Science Study (TIMSS) of comparative mathematics achievement in forty odd countries. For TIMMS, U.S., students demonstrated adequate (in fourth grade) to poor (in twelfth grade) mathematics achievement (U.S. Department of Education). To analyse whether teacher knowledge might help explain TIMMS outcomes, data on teacher training was gathered. In terms of college study, U.S. teachers appear to be comparable with their counterparts in other countries (U.S. Department of Education).

In pedagogy of mathematics teaching learning process, questioning is one of most significant competencies. There are many classrooms in which teachers rarely pose questions above the "read-it-and-repeat-it" level. Questions that demand inferential reasoning, much less hypothesis-formation or the creative transfer of information to new situations, simply do not occur with any frequency (Gall (1970); Mills, Rice, Berliner, and Rousseau (1980)).

Classroom questions are often disingenuous. Some are rhetorical: "Are we ready to begin now?" Others are mere information checks—a teacher knows the answer and wants to know if students do, too. Missing from many classrooms are what might be considered true questions, either requests for new information that belongs
unique to the person being questioned or initiations of mutual inquiry (Bly 1986, Cook-Gumperz 1982).

The questions and answers that do occur often take place in a bland, if not boring or bleak, intellectual landscape, where student answers meet only with responses from teachers at the "uh-huh" level. Even more sobering is the observation that teachers' questions often go nowhere. They may request the definition of a sonnet, the date of Shakespeare's birth, the meaning of the word "varlet"- but, once the reply is given, that is the end of the sequence. Extended stretches of questioning in which the information builds from facts toward insight or complex ideas rarely take place (Goodlad 1984, Sadker and Sadker 1985).

The very way in which teachers ask questions can undermine, rather than build, a shared spirit of investigation. First, teachers tend to monopolize the right to question - rarely do more than procedural questions come from students (Campbell 1986). Second, the question-driven exchanges that occur in classrooms almost uniformly take place between teachers and students, hardly ever shifting so that questions flow between students. Moreover, classroom questioning can be exclusive. It can easily become the private preserve of few- the bright, the male, the English-speaking (Erickson 1975, Erickson and Schultz 1981, Hall and Sandler 1982).

Questions can embarrass, rather than inquire. They can leave a student feeling exposed and stupid, more willing to skip class than to be humiliated again (Bly 1986).

Shulman (1986, 1988) proposed a framework for analyzing teacher's knowledge that distinguished between different categories of knowledge: subject matter knowledge, pedagogical content knowledge and curricular knowledge. He presented an overview of teacher preparation and concluded that the distinction between "knowledge" and "pedagogy" is a relatively recent development. Discusses different types of teacher knowledge ("content", "pedagogical content," and "strategic") and forms of knowledge ("propositional", "case," and "strategic"). He called for development of professional examinations and research-based programs of teacher education.
Shulman's (1987) model of teacher knowledge includes seven domains which constitute a minimum for describing teachers' knowledge. These were knowledge of content, pedagogical content knowledge, knowledge of educational contexts, ranging from the workings of a group or classroom to the character of communities and cultures, knowledge of the curriculum, knowledge of learners and their characteristics, knowledge of educational ends, purposes and values and their historical and philosophical grounds, and general pedagogical knowledge. Shulman's emphasis was on pedagogical content knowledge. This involves an integration of content and pedagogy - combining ideas from mathematics with what is known about teaching and learning mathematics (Cooney, 1994).

Over the past 10 years, Ball (1988) interviewed various teachers and prospective teachers, probing their grasp of principles behind school mathematics. Knowing and Teaching Mathematics (KTEM) extends this work to a transnational context. Ball concluded that, the picture that emerges is highly instructive and sobering. Mathematics knowledge of teachers does play a vital role in mathematics learning. However, it seems also that the kind of knowledge that is different from what most U.S. teacher preparation schemes provide, and we have currently hardly any institutional structures for fostering the appropriate kind of understanding.

In 1989, the National Council of Teachers of Mathematics (NCTM) published the Curriculum and Evaluation Standards for School Mathematics. This document began a widespread shift in the way many educators think, write, and talk about mathematics education in the United States. NCTM suggested that educators should approach the teaching of mathematics in new ways and proposed changes in both content (e.g., number sense and numeration, geometry, and probability) and processes (e.g., problem solving, communication, reasoning, and connections). Suggesting a broader definition and use of communication in the mathematics classroom, NCTM (1989, 6) called for an increase in students' reading, writing, discussing, representing, and modeling mathematics, because, "as students communicate their ideas, they learn to clarify, refine, and consolidate their thinking." Teachers who embraced the standards sought ways to shift the emphasis in their classrooms from talking and writing as answer-giving to talking and writing as sense-making.
Math Forum summary of research completed by Blumenfeld, Slowly, Marx, Krajcik, Guzdial and Palincsar (1991) at the University of Michigan describes project-based learning and the benefits of using long-term projects as part of classroom instruction. Blumenfeld et al (1991) initiated project-based learning in problem solving and believed that projects have the potential to foster students' learning and classroom engagement by combining student interest with a variety of challenging, authentic, problem-solving tasks. Blumenfeld et al stress that "giving the students the freedom to generate artifacts is critical to their construction of knowledge." Topics covered include authentic project design, the impact of that design on the classroom and "real world" environments, keys to success, and role of technology integrated into classroom activities.

Fennema and Franke (1992) completed a wide ranging review of the research on teachers' knowledge. They found that research on teachers' knowledge has not tended to integrate the components of knowledge but studied them in isolation. They identified pedagogy, student learning and content teachers' knowledge of mathematical representation as another component which has been isolated and studied. Fennema and Franke (1992) built up a model for examination and discussion on teacher's knowledge as it occurs in the context of the classroom. The model which shows interactive and dynamic nature of teacher knowledge, includes the components of teacher knowledge of the content of mathematics, knowledge of pedagogy, knowledge of student's cognitions and teacher's beliefs. In Fennema and Franke's model the components; teachers' knowledge of mathematics, pedagogy and learners are dynamic and interactive. Knowledge of mathematical content includes the teachers' knowledge of the concepts, procedures and problem solving processes in the domain, and related domains. It includes knowledge of underlying procedures and the relationships between mathematical concepts. Pedagogical knowledge relates to the teachers' knowledge of procedures like planning, classroom organisation, behaviour management and student motivation while knowledge of learners' cognitions involves knowledge of how students develop their understanding of particular concepts, the processes. The model illustrates the interaction between teachers' knowledge and affective factors such as beliefs. It assumes that these things will be studied within their context and not in isolation. The context determines the components of knowledge and beliefs which come into play. The dynamic nature of teachers'
knowledge and beliefs is represented by changes which occur in knowledge. Changes are the result of interactions between the three components of teacher knowledge during the process of teaching. Teachers' knowledge develops through classroom interactions with students and subject matter.

Shulman's theoretical framework, teachers need to master two types of knowledge: (a) content, also known as "deep" knowledge of the subject itself, and (b) knowledge of the curricular development. Content knowledge encompasses what Bruner (as cited in Shulman, 1992) called the "structure of knowledge"—the theories, principles, and concepts of a particular discipline. Especially important is content knowledge that deals with the teaching process, including the most useful forms of representing and communicating content and how students best learn the specific concepts and topics of a subject. "If beginning teachers are to be successful, they must wrestle simultaneously with issues of pedagogical content (or knowledge) as well as general pedagogy (or generic teaching principles)" (Grossman, as cited in Ornstein, Thomas, & Lasley, 2000).

The investigator could locate few research studies showing mathematics connections with various disciplines like science, social studies and art.

Science: According to Farmer and Farrell (1989), "Activities for Teaching K-6 Math/Science Concepts" is a revised edition of one of the products of a project, "Teaching Mathematics and Science Concepts, K-6," funded by the New York State Department of Education. This book contains lesson ideas that reflect the belief that science and mathematics are opposite sides of the same coin. Activities in this booklet (1) combine important mathematics and science in a single lesson; (2) have been tried out by classroom teachers and elementary school children; (3) involve "hands-on" activities; (4) use readily available, everyday materials; and (5) can be used as the basis for further activities. Included is a list of free and inexpensive materials that are useful in teaching science and mathematics and which include everything needed for the activities in this booklet. The topics of geometry, shapes, the earth, measuring, counting, inclined planes, work, gravity, friction, observing, classifying, angles, dew point, probability, symmetry, variation in nature, metric system, data collecting, estimation, ratios, proportion, melting, freezing, graphs, inferring, patterns, feeding and locomotion of animals, adaptations in animals, volume, ground water, and water supply are presented. A section "Sources of Further Ideas" contains a brief list of
professional journals, teacher idea/reference books, and curriculum projects, along with a list of useable junk.

Social Math: According to Porter (1993), "Social Math: Teacher's Resources" presents recommended resources for implementing activities in social mathematics, an instructional approach created by combining numerical information with social studies concepts. Describes ways to generate historical timelines, create family histories, and collect and interpret numerical data.

Arts: According to Brahier (1993), "IDEAS" presents a thematic approach to curriculum that enables students to connect topics and supports meaningful inquiry. Presents four activities for levels K-2, 3-4, 5-6, and 7-8 in which students explore problems of interest involving the theme of construction and architecture, includes reproducible worksheets.

Social Studies: According to Bloom (1994), "Data Buddies: Primary-Grade Mathematicians Explore Data" describes a project for first- and second-graders involving gathering and interpreting survey data from a student they have never met in order to identify the student at the end of the project. Includes sample curricular goals and instructional strategies.

Cochran et al (1993) provided pedagogical content knowing (P.C.K.g.) approach, based on Shulman's P.C.K approach to teaching attitudes and other teaching features. This approach emphasizes that a teacher’s knowledge and ability should include four aspects:

- Knowledge of particular subject,
- Knowledge of common teaching ability,
- Knowledge of student’s background, and
- Knowledge of the teaching environment

Krainer (1994) also proposed four dimensions of professional mathematics knowledge of mathematics teachers. They are abilities and attitudes in action, reflection, autonomy and networking.

Hirsch (1996) stated that “facts” and indeed all “subject matter” are secondary in importance to a generalized, subject independent teaching skill and the development of “higher order thinking”.

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Howe (1998) stated that since publication in 1989 of the Curriculum and Evaluation Standards by the National Council of Teachers of Mathematics (NCTM), there has been a steady increase in discussion and debate about reforming mathematics education in the U.S., including increased attention from University Mathematics.

Leou (1998) conducted a study on Teaching Competencies Assessment Approaches for Mathematics Teachers. The purposes of this study were: (1) to construct a list of assessment items; (2) to establish assessment models; and (3) to develop evaluation instruments so that there would be a direction for better mathematics teacher preparation. The research process included three steps: first, to review the literature on the characteristics of a competent Mathematics teacher’s basic skills; second, to develop assessment model and evaluation instrument; and third, to design teaching simulation situations on video to assess student teachers’ mathematics instruction performance. The simulation situation were evaluated from four dimensions, teaching skills, organization and presentation of materials, management of the learning environment, and teaching attitudes. The three main findings were: 1. Establishment of the teaching competency assessment items for mathematics teachers, 2. Establishment of the assessment model for mathematics teachers, and 3. Completion of teaching simulation situation video-tapes as the assessment instrument.

In April 2000, National Council of Teachers of Mathematics released its revised "standards document," Principles and Standards for School Mathematics (PSSM). In PSSM, communication as a standard maintained its prominent status. Now, however, the forms emphasized in the communication-process standard are verbal and written, while the symbolic, graphic, pictorial, and gestural forms are emphasized separately in a representation-process standard (NCTM 2000). The separation is not a true bifurcation; instead, it underscores the important role that representation plays in the communication of and about mathematics. NCTM (2000) explicitly acknowledged the link between the two: "Representations should be treated as essential elements ... in communicating mathematical approaches, arguments, and understandings to one's self and to others." Representation can, but does not have to, have a communicative purpose.
A report sponsored by the U.S. Department of Education (2000) regarding the effectiveness of different aspects of ‘school’ on student learning found that although much research has been conducted to identify a relationship between resources and student achievement, very little has been done to identify a link between teacher pedagogy and student learning. This study, using one hundred twenty four middle school teachers, developed a twenty item, four-point Likert survey. The survey assesses respondent disposition and preferences for utilizing traditional and inclusive teaching pedagogy. Each respondent receives a traditional and an inclusive score. The higher of the two scores is assumed to be the respondent’s strongest pedagogical preference. Observations of twenty respondents’ teaching practices and informal interviews provide information concerning the teachers’ understanding of a relationship between their perceived and enacted pedagogical practice and provide observational validity for the instrument. The findings of this study will benefit the education community by providing a better understanding of the relationship linking teacher pedagogy and its classroom enactment, a means for pedagogical teacher self-evaluation, and a better understanding of a teaching-learning classroom environment.

Niss (2002) presented a paper on Danish KOM Project (KOM: Competencies and the Learning of Mathematics), initiated by ministry of education and other official bodies for in-depth reform of Danish Mathematics Education; made an attempt to identify mathematical competencies. They specified eight competencies which were categorized into two groups. The first group of competencies was to do with ability to ask and answer questions in and with mathematics; which included, thinking mathematically, posing and solving mathematical problems, modeling mathematically and reasoning mathematically. The second group of competencies was to do with ability to deal with and manage mathematical language and tools which included representing mathematical entities, handling mathematical symbols and formalisms, communicating in, with, and about mathematics and making use of aids and tools.

Agarkar and Shirali (2002) highlighted the need for revamping pre-service courses i.e. the curriculum of pre-service courses needs to be modified to suit to present content and national interests.
Proulx (2003) conducted a case study and analysed five mathematics future teacher practices, in regard to their oral explanations. These five future teachers were in their 2nd year (2nd practicum) of a 4-year program. Individual interviews were conducted with those future teachers to better understand the rationale underpinning their decisions and classroom practices. This study revealed that while many elements of the teacher education program are appropriated by these future teachers, some are less appropriated or not at all. Data supporting this claim is as under:-

- Future teachers view of the program (from the interview analysis): Even though they followed the same program and mostly took the same courses, each of the five student teachers had a different view concerning their program (see table 2.1).

**Table 2.1**

**Showing views of the student teachers**

<table>
<thead>
<tr>
<th>Name</th>
<th>View of the Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albert</td>
<td>The program is seen as a source of potential teaching resources. It offered him, in his terms, some interesting and possible ‘tools’ (activities, problems, questions to ask, etc) to use in his teaching.</td>
</tr>
<tr>
<td>Bertrand</td>
<td>The principles/content brought forth in the program are considered optimal and ultimate: he does not question them and takes them for granted. The educators have an authoritative status for him and he ‘blindly’ follows what was suggested.</td>
</tr>
<tr>
<td>Carl</td>
<td>He recognized himself, as a teacher, in the principles brought forth in the program-involved implicitly in his practice. This program confirmed his practice and helped him to explicate (give a name to) the very practices he was enacting.</td>
</tr>
<tr>
<td>Donna</td>
<td>The enunciated principles were seen as a philosophy of teaching, in which general ideas on education and mathematics teaching were the center. She does not focus on specifics on particular subjects; she aimed at themes like encouraging students to argue, working on diverse solutions, contextualizing mathematics, and so on.</td>
</tr>
<tr>
<td>Enrich</td>
<td>The program gave him a model- in- action of teaching- not by concepts brought forth in the program, but from the way the educator was teaching. The educators were seen as teaching-in-action model.</td>
</tr>
</tbody>
</table>
Future teachers teaching practices:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albert</td>
<td>Even though Albert worked on a pragmatic basis showing procedures to factorize polynomials, he was ‘pitching-in’ activities, problems and introduction settings that were worked on in his teacher education program.</td>
</tr>
<tr>
<td>Bertrand</td>
<td>Bertrand, as a re-producer of what was asked from him in his courses, used ideas that were suggested in the program in a technical way—not knowing exactly why he was focusing on them.</td>
</tr>
<tr>
<td>Carl</td>
<td>Carl, who said he implicitly knew everything already, used principles like ‘cognitive conflicts’ and ‘representations’; however he used them in a way that differed somewhat, in our view, from what educators previously meant.</td>
</tr>
<tr>
<td>Donna</td>
<td>She was struck between two principles concerning mathematics teaching: even though she believed in the approach of taking into account the strategies developed by the students, she could not overcome her tendency to see ‘real’ mathematics as exclusively formal- and indeed she institutionalized the conclusions/synthesis of the course in a formal way after having introduced in a contextualized way.</td>
</tr>
<tr>
<td>Enrich</td>
<td>Enrich appropriated intuitively a model for teaching in-the-action from the educators action (and not from the principles or notions brought forth) and brought them forth in his own practices. He treated his students as mathematics didacticians by showing them common errors made by students and asking them to ‘make sense’ of those errors and make them ‘understand’ the ‘what’ and ‘why’ of those students thinking- a activity often done in his teacher education program.</td>
</tr>
</tbody>
</table>
He concluded that it is interesting to see how differently the future teachers made sense of the mathematics teacher-education practices. It is also interesting to trace a tentative analysis of the appropriation of these practices by student teachers—how did they make their mathematics teacher education theirs? In one category, there in Enrich, Donna and Carl who appropriated principles on a general level and were not stuck on particular ways of presenting specific mathematics content. Whereas Enrich focused on teaching-in-action, Donna grasped a philosophy of teaching and Carl appropriated general principles. They created their own way of being a teacher (with no regards to content). It is a way of being rather than a way of doing. In another category we have Albert who worked mostly on a pragmatic level using ideas from the program only in a technical way and at specific moments. Finally, in another category, there is Bertrand who reproduced what he was taught in the program without really knowing why his words were mostly “because we had to”. The appropriation is minimal, almost non-existent. His actions were guided by authority.

Neria and Amit (2004) conducted a study on students preference of non-algebraic representations in mathematical communication. This research study deals with the modes of representation that ninth-graders choose in order to communicate their problem solving paths and justifications, and the relation between these modes of representations and achievement level. The findings are based on analysis of 350 answers to problems that demanded communication of reasoning, explanations, and justifications. The results indicate that only a few students, who are very high achievers, choose to communicate via algebraic representations, even after two extensive years of learning algebra. These results might be related to difficulties students have with the abstraction of algebra and the way algebra is taught in school—an issue that should be considered by curriculum developers and teachers.

According to The Ontario Curriculum prepared by Ministry of Education, Ontario for grades 1-8 (2005), seven mathematical processes support effective learning in mathematics, namely problem solving, reasoning and proving, reflecting, selecting tools and computational strategies, connecting, representing and communicating. Ministry of education, Ontario (2005) listed the mathematical processes that support effective learning in mathematics. The mathematical processes are problem solving, reasoning and proving, reflecting, selecting tools and
computational strategies, connecting, representing and communicating. The mathematical processes can be seen as the processes through which students acquire and apply mathematical knowledge and skills. These processes are interconnected. Problem solving and communicating have strong links to all the other processes. A problem-solving approach encourages students to reason their way to a solution or a new understanding. As students engage in reasoning, teachers further encourage them to make conjectures and justify solutions, orally and in writing. The communication and reflection that occur during and after the process of problem solving help students not only to articulate and refine their thinking but also to see the problem they are solving from different perspectives. This opens the door to recognizing the range of strategies that can be used to arrive at a solution. By seeing how others solve a problem, students can begin to reflect on their own thinking (a process known as “metacognition”) and the thinking of others, and to consciously adjust their own strategies in order to make their solutions as efficient and accurate as possible. The mathematical processes cannot be separated from the knowledge and skills that students acquire throughout the year. Students must solve problems, communicate, reason, reflect, and so on, as they develop the knowledge, the understanding of concepts, and the skills required in all the strands in every grade.

Noblitt (2006), University of Cincinnati conducted a study on “The effects of instruction on the algebra self-efficacies of prospective middle grades teachers”. This study used qualitative as well as quantitative research methods to investigate the effects of algebra content course on the algebra self-efficacies of prospective middle grades teachers. This research was conducted at an urban research university in the Midwest. Surveys of and semi-structured interviews with prospective middle grades teachers and observations of and interviews with the instructor of the algebra content course provided the data. By systematically comparing the algebra self-efficacies with which prospective middle grades teachers entered the mathematics content course to the algebra self-efficacies with which they exited the course, along with examining the ways in which self-efficacy was addressed by the instruction of the mathematics content course, this research provides insight into the development of the algebra self-efficacies of prospective middle grades teachers and the role that the instruction of a mathematics content course played in that development. The prospective teachers had medium-level perceived self-efficacies upon entering the course and exiting the
course. There was no statistical difference between the pre-course and post-course surveys measuring algebra self-efficacies. The prospective teachers’ perceived self-efficacy on algebra tasks did not align with their performance on the tasks.

Peker and Erdogan (2009) conducted a study on Teaching anxiety and the mathematical representations developed through Webquest and spreadsheet activities. The purpose of this study was to find out the effects of mathematical representations developed through WebQuest and spreadsheet activities on the teaching anxiety level of the pre-service elementary school teachers in mathematics. The number of pre-service elementary school teachers involved in this study was seventy three. Thirty five of the participants were in the experimental group and thirty eight of them were in the control group. Whereas the participants in the experimental group developed WebQuest activities during seven weeks of mathematics instruction, the others in the control group did spreadsheets activities in the classroom. The researchers used a Likert-type questionnaire, the Mathematics Teaching Anxiety Scale (MATAS) including twenty three items as pre- and post-tests to investigate teaching anxiety level of the participants in mathematics. After the collection of the data, the researchers used the independent samples t-test and ANCOVA to analyze the quantitative data. The study indicated that there was a statistically significant difference found in terms of teaching anxiety level between the groups favoring the one who developed WebQuests. In other words, developing WebQuest activities reduced the teaching anxiety levels of the pre-service elementary school teachers more than doing spreadsheet activities in mathematics.

Jumani, Akhlaq, Malik, Chisht and Butt (2010) conducted a comparative study on the professional competencies of mathematics teachers trained through conventional and distance system of education in Pakistan. The study analysed the difference in the professional competencies of mathematics teachers trained through conventional and distance system of education in Pakistan. It involves a randomly selected group of 600 teachers of which 300 were trained through conventional and 300 trained through distance system. The study focuses on the following professional competencies of mathematics teachers:- Teaching Skills, Management of Learning Environment, Teaching Attitude, and Teaching Techniques. The finding of the study came up as: (a) the teachers trained through distance system were
competent in the area of “Teaching Skills”, (b) the teachers trained through distance system of education were proficient in the “Management of Learning Environment” (c) the “Teaching Attitude” of distance teachers was significantly better than the teachers trained through conventional system of education, and (d) the “Teaching Techniques” of teachers trained through distance system of education were better than the teachers trained through conventional system. On the basis of findings and conclusions following recommendations were drawn: (1) the duration of teacher training workshops/courses/program, especially designed for the secondary school mathematics teachers, should be increased to eight to ten weeks, (2) the school heads should closely monitor the in-service training workshops and necessary guidelines should be provided to the trainers and trainees,(3) the basic qualification for the post of secondary school teachers should at least be enhanced by two years, (4) all secondary schools should be provided with a teaching kit and modern facilities, so that teachers may improve their classroom instructions, and (5) the duration of the B.Ed. program may be increased from three to four semesters, and the fourth semester might focus on the teaching skills and teaching competencies of various subjects.

There is growing consensus among mathematics teacher educators and researchers (Thompson & Thompson, 1994; Even & Lappan, 1994; Ball, in press; Schifter, in press) that preparing future teachers to be effective in the standards-based reform climate depends in part upon teachers’ experience of “qualitatively different and significantly richer understanding of mathematics than most teachers currently possess” (Schifter & Bastable, 1995). But Carpenter (1995) argued that, even when teachers are taught additional content in their undergraduate programs, they do not necessarily apply that knowledge to their teaching, or even retain that knowledge. He claims that the way in which teachers come to understand the content is critical, and its relationship to future teaching practice is not well understood; “... teachers need to understand how their content knowledge applies to their teaching... [so] that the content is learned in a context that provides some links with how that knowledge is used in teaching” (Carpenter, 1995).

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 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.

2.4 STUDIES RELATED TO ACHIEVEMENT MOTIVATION

Carlson (1973) conducted a research project on ‘a career education model: research project in achievement motivation for junior high school teachers’. The study investigated the effects of an in-service teacher-training workshop in achievement motivation and career cluster simulations on career decision-making skills for junior high students. Ninety-three teachers and counselors from 30 schools, representing all areas of Washington, D. C., participated in the two-week in-service career education workshop. Sample control and experimental student groups, randomly selected from the participating schools, and were established at seven of the schools. The student population was predominantly black with 50 percent qualifying for educational aid for the disadvantaged. Career simulations were used with each experimental group while each control group was conducted with the visual format; both groups in each school were conducted by the same teacher. Residual effects on students were measured by
the results of pretesting (October 1972) and post testing (January 1973) using Crites Vocational Development Inventory. Statistically significant differences between experimental and control groups were indicated in five of the seven schools; teachers participating in the workshop were able to produce "positive change" in student vocational maturity scores. Workshop participants viewed the workshop positively and reported followup implementation in career simulations.

According to Hawley (1985), in order to increase teacher competence career ladder plans should be done. There are some principles to be designed for career ladder plans. These are:

- For high performance, economic rewards are important.
- In order to keep higher levels of pay and status, teachers carry on showing high performance.
- There should not be any competitive rewards which can discourage peer interaction and social approval, important to effective teaching.
- Fair and predictable assessment measures should be used.

"The need to avoid pain and the need for psychological growth" are two basic elements found in job enrichment theory (Silver, 1982). It is said that motivation factors should be intrinsic which present tasks that are more enjoyable, interesting and psychologically rewarding. Achievement, recognition, work, responsibility, advancement and possibility of growth take place in that group. On the other hand, other factors are extrinsic in terms of the context or setting where the work is performed. Organizational policy and administration, technical supervision, salary, working conditions, status, job security, effects on personal life, and interpersonal relations with superiors, peers and subordinates are in that group.

Johnson (1986) states that there are three theories of motivation and productivity that teacher motivation are based on.

- Expectancy theory: It is probable for a person to struggle for work if there is an expected reward such a bonus or a promotion that is worth working.
• Equity theory: Unfair treatment for their efforts and achievements makes individuals displeased.

• Job enrichment theory. The more varied and challenging their work is, the more productive employees become.

According to Dinham and Scott (1997), the considerable changes that have occurred in the education system over the last decade, combined with an ageing and largely immobile teaching force and an expected expansion of teacher roles and functions, led researchers to consider the effect these factors have had on the satisfaction, motivation and occupational health of teachers and school executives. In an attempt to develop a nationwide instrument suitable for identifying and quantifying these factors, teaching staff at 71 public schools in Sydney's Metropolitan west were surveyed. The results obtained from this survey are hoped to validate an understanding of teacher satisfaction, dissatisfaction, values and health, and be used as a benchmark for tracking, explaining, planning and predicting teacher welfare at the school and other educational levels. Respondents were primarily asked questions relating to their level of satisfaction with various aspects of the teaching profession, including their ability to influence students success and attitudes; their contribution to the school and education system; current work hours and salary; opportunities for promotion and involvement in school decision making; the amount of recognition teachers receive; the status of teachers; achievement of professional goals; the current procedure for selection, hiring and transfer of teachers and how they felt when they first started teaching. In the second part of the questionnaire, respondents were asked to indicate how important the achievement of certain goals was to them. Such goals included having a close and satisfying relationship, to obtain rewards and recognition, be committed to a cause, retain or achieve financial well-being, to avoid stress, influence others and to establish a career. Emotional and physical health were addressed in the third part of the questionnaire, asking the respondent if they had recent problems with lack of concentration, lost sleep, stress, depression or inability to make decisions. Background variables include age, sex, country of birth, first language, highest qualification, current teaching position, years of service and years taught at current school, and why they wanted to become a teacher. The sample comprised of all teachers employed at government schools located in the Metropolitan
West region of Sydney. The Western Sydney region was chosen because of convenience of access and because of its heterogeneity, ranging from small rural primary schools to large urban high schools, and from schools with large proportions of students with languages other than English to schools with negligible numbers of students from this background.

Dornyei (2001) defines teaching as a profession whose energy is supplied from intrinsic motives and states that there are some damaging elements which weaken and destroy the intrinsic character of teacher motivation. There is a high correlation between intrinsic motivation and teaching. Internal desire to educate people, to give knowledge and value is always in teaching as a vocational goal. Fulfillment of teaching is provided with intrinsic rewards. "Performing a behavior for its own sake in order to experience pleasure and satisfaction such as the joy of doing a particular activity or satisfying one’s curiosity" is the definition of intrinsic motivation (Dornyei, 2001). With the help of this definition, intrinsic reward is divided into most satisfying views of teaching as a profession the educational process itself, and, b) the subject matter. The first one is about the teacher’s performance affected by working with students and perceiving the changes in the students’ performance and behavior. The second one is related to studying a valued field and new information in it so it leads to increase one’s own level of professional skills and knowledge. Such intrinsic rewards make teachers forgo high salaries and social recognition.

According to Pelletier and et. al, (2002), there are three types of pressure that affect teachers’ self-determined motivation.

- Being responsible for students’ behavior and students performing up to standards.
- Being forced to follow colleagues’ teaching methods or involvement in school activities.
- Having limited freedom in determining the course’s curriculum or following a certain curriculum decided by the school’s administration.

Bays, (2003) conducted a study titled “Conceptualization of Teachers Role in Urban Student Motivation”. Teacher’s perceptions of and strategies to increase motivation in students were examined. Seventeen teachers from two urban high
schools were utilized in this study. The teachers responded to a survey comprised of thirty questions exploring teacher concept of motivation, classroom strategies and teacher attitudes toward students. Focus groups looked into the subject further. Frequencies were tallied for each survey question. All of the respondents saw motivating their students as part of their role. The teachers defined motivation as a noun, verb, or verb involving a teacher action. Those who defined it as a teacher action saw instilling motivation as an important task for the teacher to undertake and cultivate within their students. The strategies to increase motivation that teachers listed fell into two main categories: variety and relevance. The relationship between teacher and student, and the effect it had on motivation levels was also explored.

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 above 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), Dornyei (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.

2.5 STUDIES RELATED TO TEACHING APTITUDE

The generally accepted definition of aptitude, according to Carroll (1973), is that it is an innate, stable quality. In addition to Carroll, Anselmo, 1993; Alexiou, 2001; Dornyei, 2005; Skehan (as referenced in Dornyei, 2005), and all found aptitude to be a constant factor, a “biological endowment” that can’t be taught (Anselmo, 1993). Some early researchers explored whether aptitude can be increased through specialized instruction.

Politzer and Weiss (1969) found that not only did training adults on cognitive tasks fail to increase aptitude scores, but the students resented the training, finding it irrelevant and useless (as referenced in Carroll, 1973).

Sharma (1971) aimed at studying the relationship between characteristics possessed by teachers and teacher effectiveness with a view to predicting teaching
success. A representative sample consisting of 700 teachers (431 males and 269 females) obtained from government normal schools of Uttar Pradesh were used in the study. The research tools used for the study were: a rating scale for measuring teaching effectiveness, a rating scale for measuring teacher’s personality, the teaching aptitude test by Pandey, a classroom teaching evaluation form, an inventory of self appraisal for teachers, teacher information sheet, Minnesota teacher attitude inventory and observation data sheet. Multiple correlation technique, using Aitken’s method of pivotal condensation was used to analyse the data. Multiple regression equations were obtained for the criterion variables, namely, personality rating scores, classroom rating scores and the final theory examination marks. It was reported that variables accounted for seventeen, twenty, and twenty percent of variance of the three criteria variables respectively. The sex variable, as a predictor, was found to be relevant for predicting personality aspects, but not necessarily for classroom ratings. Indirect influence by teachers and pupil talk seemed to have high positive association with teaching aptitude test and academic grades, while teacher talk had negative correlation with scores on teaching aptitude test and academic grades. On the whole the combination of five predictors, i.e., teaching aptitude, academic grades, socio-economic status, teaching experience and age, in order of their arrangement appeared to be sound predictors of teacher effectiveness.

Aptitude-Treatment Interaction (ATI) -- the concept that some instructional strategies (treatments) are more or less effective for particular individuals depending upon their specific abilities. As a theoretical framework, ATI suggests that optimal learning results when the instruction is exactly matched to the aptitudes of the learner. It is consistent with theories of intelligence (e.g., Gardner, Guilford, Sternberg) that suggest a multidimensional view of ability.

Davis (1983) describes three approaches to the use of ATI's to improve learning. The capitalization approach says go with the student's strengths. The compensation approach says provide a crutch if weakness is predicted, and, the remediation approach, in which the weakness is worked on until it is overcome. One limitation of the ATI model is it assumes that aptitudes are traits and are relatively fixed over time. The model is also static and only a few dimensions are summed to describe a given person. He said that typically when we advocate differential
treatment for different groups of learners we do so because we believe that it is more effective, efficient or less costly to do so. He referred to illustrations from Cronbach and Snow (1977). For example we might have a treatment, say graduate school, which could be applied to all who wanted it.

Figure: 2.2 Showing The Scheme for Examining Predictive Validity.

Cronbach and Snow (1977), explained it as, if standards were at all rigorous success would be unlikely for many and therefore scarce resources would be wasted. So a criterion measure of ability, the "x" in figure, might be applied, let's call it the Graduate Record Examination (GRE). We then could establish a cut off score, say "x*". Looking at the mean of persons above "x*" in relation to the mean of all persons taking the GRE we can see that we save a segment of resources and probably graduate more candidates by using such a measure. This is the basis of the beginnings of the ATI. Note that it is assumed that the world is linear and related to a single variable for this kind of a prediction model. Based on single aptitude model it can be said that the imposition of a cut off score will improve the capability of the overall body of learners by selecting those who are more likely to succeed.

Winnie (1977) conducted a study on aptitude treatment interactions in an experiment on teacher effectiveness. Winnie stated that aptitude-treatment interactions (ATI) are relatively unexamined in research on teacher effectiveness but
may be important in describing the teaching-learning process. In an experiment on teacher effectiveness, 399 sixth-grade students were taught ecology for nine lessons. Trained teachers used one of eight factorially defined teaching treatments which varied teacher behaviors of structuring, soliciting, and reacting. Generalized regression analyses on dependent variables of multiple choice, attitude, and perception of teaching showed aptitudes to be major predictors relative to teacher, treatment, and ATI effects. ATI effects were more frequent and stronger predictors than treatment effects in almost all cases, though ATI terms usually absorbed only one to two percent of variation in the criterion variables. The methodology and findings of this study suggest changes for research on teacher effectiveness.

According to Snow (1989), the aim of ATI research is to predict educational outcomes from combinations of aptitudes and treatments. He summarizes the main conclusions of Cronbach & Snow (1977) as: (1) aptitude treatment interactions are very common in education, (2) many ATI combinations are complex and difficult to demonstrate clearly, and no particular ATI effect is sufficiently understood to be the basis for instructional practice. Furthermore, Snow identifies the lack of attention to the social aspects of learning as a serious deficiency of ATI research. He states: "Learning style differences can be linked to relatively stable person or aptitude variables, but they also vary within individuals as a function of task and situation variables."

Harley and Hart (1997) revisited the question of “learned aptitude,” taking a different task: learning one language, especially in childhood, may be the key to learning another with a high degree of aptitude. Although aptitude testing was originally intended for adults, Harley and Hart (1997) found that some aptitude differences are present in children, which can be taken as further evidence that these might be a genetically determined, fixed language talent.

Yeh (2004) conducted a study on “Nurturing reflective teaching during critical-thinking instruction in a computer simulation program, Computers & Education”. Adapting training methods to specific teacher traits to best facilitate the training effects for preservice teachers is an important, yet neglected, topic in aptitude-treatment interaction research. This study investigated interactions between four personal traits (CT-dispositions, thinking styles, CT-skills, and intrapersonal...
intelligence) and two designed treatments on preservice teachers' behavior change during a computer-simulated teaching experience. One hundred and seventy-eight pre-service teachers participated in this study. The CS-TGCTS simulation program was employed to measure the pre-service teachers' actual use of effective teacher behaviors, as well as the four targeted personal traits which were measured by three Likert-scale inventories and one multiple-choice test. The results suggest that pre-service teachers with high levels of CT-dispositions, CT-skills, and intrapersonal intelligence - as well as those with judicial or legislative thinking styles - are mindful, analytical, and reflective in their teaching practices and therefore more likely to continually improve their teaching skills.

According to Babu and Rao (2007), "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, any teacher cannot perform his/her duty properly. Identifying the very role of teaching aptitude in teaching profession, this study has been undertaken to identify the teaching aptitude of primary school teachers. The primary school teachers are holding high teaching aptitude and they are considered as most efficient teachers. The gender of the teacher, locality of the school, management of the school, experience of the teacher and age of the teacher have no influence on the teaching aptitude of the primary school teachers. This study will help the administrators and teachers in performing their job well."

Saharan and Sethi (2009) conducted study investigating a study of mental ability of secondary school teachers in relation to their general awareness, attitude and teaching aptitude. The author in this study find out the relationship of mental ability, general awareness, teaching attitude and teaching aptitude. The data was collected through Teacher's general awareness scale, Teacher's mental ability scale, Teacher's teaching aptitude Scale and Teacher's attitude Scale. These tools were administered on 600 secondary and senior secondary school teachers from 55 schools of Hanumangarh and Sri Ganganagar districts of Rajasthan. The sample is from Government and non-Government schools of urban and rural areas. It was noted that (i) There is no significant difference in mental ability on the basis of sex, type of institution area and age. (ii)There is no significant difference in the general awareness
on the basis of sex, area and age but non-government teachers have more general awareness than government teachers. (iii) The teaching attitude and aptitude varies according to sex and age but types of institution and area have no effect on it. Male teachers have high teaching attitude but low aptitude than females. The teachers above 40 years have higher teaching aptitude and attitude than teachers below 40 years. (iv) There is a positive and significant correlation between variables mental ability and general awareness and mental ability and teaching aptitude irrespective of age, sex and type of institution. (v) There is no significant correlation between teaching attitude and mental ability with reference to sex but there is positive and significant correlation with respect to age and type of institution.

Khatal (2010) conducted a study on psychological correlates of teacher effectiveness. The study examined the relation of some personality variables- teaching aptitude, job-satisfaction and marital adjustment with teacher effectiveness at the secondary level. The Teacher Effectiveness Scale was given to a sample of 100 teachers belonging to the secondary schools of Nanded city.

The psychological tests for studying the variables of teaching aptitude, job-satisfaction and marital adjustment were also administered. He stated that aptitude refers to certain basic abilities which are needed in a person for effectively performing a specific skill or job (Mailer, 1970). The job of teaching too requires certain basic abilities which may be seen as more meaningful for handling related teaching learning situation. The cognitive abilities which include perceptual clarity, organizational ability, environmental sensitivity and good language may be some of the basic abilities required to perform the job of a teacher. A person in possession of such related abilities may be taken as having high aptitude for teaching. We may therefore expect a close relationship between teaching aptitude and teaching effectiveness. The results showed that effective teachers have been found to show higher aptitude for teaching than the non-effective teacher at secondary level. He also concluded that, effective teacher who possesses higher aptitude for teaching would find the teaching job more fulfilling and satisfying than the non-effective teachers. Also the factor of adjustment in marriage does not seem to effect teaching effectiveness.

The perusal of above literature reveals that there are studies which indicate the positive relationship between teaching aptitude and teacher effectiveness (Sharma,
The investigator could not locate any research study on the 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 (Politzer and Weiss, 1969; Harley and Hart, 1997).

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

### 2.6 Emergence of the Problem

The traditional didactics/curriculum allowed millions of people to be taught reliable procedures for finding correct answers to important problems, without either the teachers or the students having to understand why the procedures worked. At the same time, students with mathematical aptitude could learn substantially more mathematics, enough to support various technical or academic careers. This has to be encountered as a major success.

However, the times have changed. The success of the traditional didactics/curriculum has fostered a mathematically based technology, which in turn has created conditions in which that didactics/curriculum is no longer appropriate. There are at least two reasons for this. First, we have cheap calculators that will do (at least approximately) any calculation of the elementary curriculum (and much more) with the push of a couple of buttons. These machines are typically much faster and more reliable than we are in doing these calculations. It has always been one of the strengths of mathematics to seek reliable and systematic methods of computation, which has often meant creating algorithms. Anything that has to be algorithmized can be done by a computer. Automation of calculation is no longer a problem working people usually have to worry about. At the same time, it means that calculation is much more prevalent than before. Hence, people have to spend more time in...
determining what calculation to do. This is the second reason that mathematics education (didactics/curriculum) needs to change.

Two divergent educational philosophies have served as theoretical frameworks in designing competency-based programs: the behaviouristic or functional view, and the humanistic or holistic view. The behaviouristic or functional approach defines roles and builds curricula in terms of highly refined, specifically stated skills. The humanistic approach views life from a holistic perspective and builds curricula that incorporate elements of culture, personality and citizenship. Proponents of humanistic approach believe that education cannot be confined to the narrowly defined and task-specific curriculum, which lacks breadth and inhibits intellectual and moral growth. They claim that the primary purpose of curriculum is to educate students with a full intellectual and social understanding, not simply train them for a specific occupation. Functionalists, on other hand suggest that competency in practical skills does not detract from the value of education; rather it enhances the education students receive by assuring them that their efforts will be regarded in the market place.

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 study was delimited to identification of skills specific to mathematics teaching and development of instructional material.

New curriculum materials and standards also raise issues about the depth of mathematical understanding needed by teachers. The NCTM Professional Standards, for example, suggest that teachers “orchestrate discourse by deciding what to pursue in depth from among the ideas that students bring up in a discussion” (NCTM, 1991). Teachers may also need deeper mathematical understanding in order to promote mathematical sense-making, problem solving, reasoning, and justification. Ball observes “elementary teachers, most of whom experienced school knowledge as given—and who acquired facts and memorized rules—must invent a teaching that engages students in complex reasoning in authentic contexts”. Lampert (1990) foreshadowed the current content need in her choice of the single indicator of an ideal mathematics teacher: “whether that teacher could give students at the grade level he or she is teaching a mathematically legitimate and comprehensible explanation for why the procedures students are using are appropriate or not, or why the answers they are giving are correct or not” (Lampert, 1990).

Despite strong mathematics community consensus about the importance of subject matter knowledge, only in recent years has the teacher preparation research community been able to assemble a convincing case that subject knowledge matters in teaching. Begle and Geeslin (1972), for example, found that teachers' mathematical preparation did not seem to affect students' test performance. McDiarmid, Ball, and Anderson (1989) conclude: “Recent research highlights the critical influence of teachers' subject matter understanding on their pedagogical orientations and decisions. . . . Teachers' capacity to pose questions, select tasks, evaluates their pupil’s understanding, and makes curricular choices all depend on how they themselves
understand the subject matter”. Research perspectives and methodologies are increasingly useful in helping to confirm and illuminate impressions and beliefs about depth and breadth issues.

Many mathematics teacher educators contend that teachers, in addition to knowing mathematics, also need to know and experience mathematical inquiry and the “practice” of mathematics (NCTM, 1991; Ernest, 1994; Copes, 1996). Where do prospective teachers acquire mathematical “habits of mind” (Brown, Collins, & Duguid, 1989; Cuoco, Goldenberg, & Mark, in press)? How can study of the history and philosophy of mathematics be a meaningful and appropriate part of the mathematical preparation of teachers? How can teachers learn to appreciate the coherence of mathematics, so that it informs their selection of curriculum materials and their lesson planning? What is meant by mathematical “practice”? What aspects of mathematical practice are most defensibly connected to teaching and learning? Preservice programs for elementary teachers are very crowded and allow little time for study of mathematics. Can preservice teachers learn mathematics outside of their mathematics content courses, such as in their clinical experiences, from their cooperating teachers and supervisors, or from mathematics methods courses? Can studying the practice of mathematics teaching lead to deeper knowledge of mathematics? Can pre- and post-undergraduate experiences be viewed as part of a teacher's mathematical preparation? How can graduate credit be given for elementary mathematics? In what ways do teachers need to “own” knowledge before teaching?

There are hard questions concerning whether prospective teachers should learn mathematics in courses specially designed for teachers. Should we imagine “every student a teacher”, and thus provide experience appropriate for prospective teachers through regular departmental mathematics course offerings? Or, do prospective teachers need to “come to know” particular mathematics in particular ways that will be most influential for their subsequent practice in classrooms? Who has the proper authority and expertise to make such judgments?

The investigator felt the need to investigate further whether mathematics teachers need deeper mathematical understanding in order to promote mathematical sense-making, problem solving, reasoning, and justification among mathematics students. Mathematics teachers should have in depth understanding of the subject
matter as well as pedagogy of teaching mathematics. The area needs to be explored extensively.

The United Kingdom audits mathematical subject knowledge and the skills needed to interpret assessment information as part of the requirements for Qualified Teacher Status. A report from the Australian House of Representatives Standing Committee on Education and Vocational Training (2007) on their inquiry into initial teacher training placed a strong emphasis on preparation to teach literacy and numeracy and noted widespread concerns about low skill levels in these areas amongst pre-service teachers.

The investigator analysed that there is a worldwide felt need of revamping pre service teacher training courses for mathematics teachers.

Assessment has always been an important component of any educational reform. Review of assessment related studies indicate that in recent years educators have emphasized the importance of alternative assessments, but still there is lack of research on assessment of exit competencies of teachers/prospective teachers. Moreover the researcher could not locate any study related to the development of assessment criterion for exit competencies of prospective mathematics teachers.

One of the most important factors’s which influences a student’s performance in mathematics are the mathematics teachers and the mathematics lessons they receive in school. Teachers are the true driving force behind the improvement in educational quality, and effort to improve student’s mathematical achievement cannot succeed without parallel attention to their teacher’s competence. In order to teach school mathematics, the teacher must have a complete mastery of it which can be acquired by being proficient in mathematics of a much higher level than that which is taught in the classroom. The Glenn Commission (U.S. Department of Education, 2000) stated that “High quality teaching requires that a teacher have a deep knowledge of subject matter. For this there is no substitute.”

Askew (1999) noticed that for British Elementary Teachers, “being highly effective was not positively associated with higher levels of qualification in mathematics”.

The investigator found that most of the studies have been conducted in advanced countries. There is need of conducting such studies in developing countries, like ours.

For the present study, variables of achievement motivation and teaching aptitude have been selected for the following consideration. To possess a competence (to be competent) in some domain of personal, professional or social life is to master (to a fair degree, modulo, the conditions and circumstances) essential aspects of life in that domain. Mathematics competence means the ability to understand, judge, do, and use mathematics in a variety of intra- and extra- mathematical contexts and situations in which mathematics play or could play a role.

Competency refers to a skill performed to a specific standard under standard conditions. Behaviour of an individual at a specific situation is based upon the skills and knowledge possessed by the individual, which in turn are largely influenced by individual’s aptitude and other personality characteristics. Aptitude i.e. the specific capacity to do a certain job, plays a significant role in performance of an individual at a job position. Teaching aptitude of prospective mathematics teachers influences their behaviour and hence performance, while delivering mathematics lessons in the classroom situations. Other personality characteristics of an individual also influence his/her behaviour in a particular situation. The goal oriented behaviour of an individual with a felt need (motive) and a power to achieve higher (achievement), guides the individual to perform better in his/her environment. Achievement motivation is a task-oriented behaviour that allows the individuals performance to be evaluated according to some internally or externally imposed criterion. It is a construct designed to explain inter and extra individual differences in the orientation intensity and consistency of achievement behaviour. Essentially, competencies underlie the behaviours thought necessary to achieve a desired outcome. A competency is something one can demonstrate (Weightman, 1994).

The variable wise justification of the problem leaves much scope for studying the effectiveness of competency-based approach in developing exit competencies of prospective mathematics teachers.
2.7 FOLLOWING ISSUES / GAPS EMERGED

From the perusal of literature discussed above, following issues / gaps emerged:-

1. Various investigators approved competency-based approach and opposed traditional approach; but at the same time some argued against this approach. The conflicting findings highlighted the gaps in the field of research on competency based education and training.

2. The effect of competency based education and training has not been studied in relation to those variables which might have an impact on teacher effectiveness.

3. Various mathematical competencies investigated exhibit contradictory findings. For instance, few studies indicate that mathematical content knowledge of a mathematics teacher is associated with mathematical competence and confidence of the teacher; on the contrary, there are studies which highlight that in a subject like mathematics, teacher content knowledge has nothing to do with teacher’s performance. Such issues need further exploration.

4. Very little work has been done on the variable of achievement motivation in the area of teacher education / teaching.

5. No work has been done on effect of teaching aptitude on exit competencies essential for mathematics and mathematics teaching competency.

6. Very little work has been done on developing exit competency based assessment tool for mathematics teachers / prospective teachers. No such tool could be located in Indian situations.

Hence, the present problem reads as:-

2.8 STATEMENT OF THE PROBLEM

EFFECTIVENESS OF COMPETENCY-BASED APPROACH IN DEVELOPING EXIT COMPETENCIES AMONG PROSPECTIVE MATHEMATICS TEACHERS IN RELATION TO ACHIEVEMENT MOTIVATION AND TEACHING APTITUDE
2.9 **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.

2.10 **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 Achievement Motivation and Low Achievement Motivation differ in gain scores on Mathematics Teaching Competency.

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

8a. To study whether groups trained through Mathematics Competency 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 Strategy Teaching Aptitude on Mathematics Content Competencies.

9a. To study whether groups trained through Mathematics Competency 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 Strategy Teaching Aptitude on Mathematics Process Competencies.

10a. To study whether groups trained through Mathematics Competency 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 Strategy Teaching Aptitude on Mathematical Pedagogical Competencies.

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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.

2.11 HYPOTHESES OF THE STUDY

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.

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

8.

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 Teaching Aptitude group and Low Teaching Aptitude group in mean gain scores on Mathematics Teaching Competency.

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