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Competency in Mathematics Teaching:

Subject Content Knowledge, Pedagogical Content Knowledge and Attitudes Toward Teaching Mathematics

By

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December 2002

Certificate of Originality

I certify that the substance of this thesis has not

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Abstract of Thesis Entitled

Competency in Mathematics Teaching: Subject Content knowledge, Pedagogical Content Knowledge and Attitudes Toward Teaching Mathematics

Submitted by

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Abstract: This study investigated pre-service primary mathematics teachers' teaching practice (TP) performance in the context of their subject content knowledge (SCK), pedagogical content knowledge (PCK) and attitude towards mathematics teaching (AMT). The interrelationships among these variables are analyzed too. Attitudes toward mathematics teaching and previous SCK achievement were elicited using twenty Likert-item statements and their previous highest public mathematics examination results respectively whilst information on student teachers' PCK achievement and TP performance were obtained through direct teaching observation. The sample consisted of 104 student teachers drawn from two different training programmes, 2-Year Certificate of Education (CE)

Course and 4-Year Bachelor of Education (BEd) Programme, at the first stage. Hence 52 student teachers were invited to participate in the second stage, TP supervision. Differences across programmes, year groups and gender were investigated. This study found that AMT has a positive effect on TP performance and it is also positively correlated with PCK achievement. However, it is surprising that subject content knowledge (SCK) has no statistically significant relationships with AMT, PCK achievement and TP performance. There were no substantial gender-related differences on AMT and SCK achievement; however, female student teachers performed better than male student teachers on tasks requiring patience on preparation of lesson plans and teaching aids, explanations of mathematical concepts and making discussion with pupils. Besides, and surprisingly, CE student teachers had better PCK than BEd student teachers and CE student teachers also improved more than BEd student teachers in AMT by comparing their Pre- and Pro-TP AMT scores. These findings have important implications for the design of teacher training programmes and teaching effectiveness in mathematics. It is recommended that similar research be replicated for secondary student teachers, full time kindergarten, primary and secondary teachers and with questionnaires written in Chinese if necessary.

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Chapter 1: Introduction

1.1 Background of the Study

In recent years, since Hong Kong returned to China, Hong Kong people have lived in a rapidly changing era in terms of technological, economic, political and social transformations. Hong Kong Education Commission (EC) (1996) stated in its consultation document that

> **"With the restructuring of the economy from manufacturing to a service-oriented economy, Hong Kong has experienced a change in labour market demands. Hong Kong is now one of the world's foremost financial centres, a hub of regional telecommunications, transport and trading, a leading tourist and convention destination and a major exporter of professional services to the rest of the region, in particular China. We require a labour force, which is informed and knowledgeable, highly qualified and specialized, with advance skills and the ability to think independently and to communicate well. We need a community of well educated and motivated individuals committed to the betterment and development of Hong Kong." (p.5).**

In order to make Hong Kong still internationally competitive, changing its developing focus from manufacturing to a service and finance orientation is a must. Hong Kong has to face challenges and demands. For achieving this mission, there is no doubt that Hong Kong has to rely on quality education for building a competent workforce to promote social and economic development. Consequently, the desire to improve the educational standards in Primary and Secondary schools has become a high profile issue in Hong Kong. Thus, Hong Kong EC (1997) concluded that professional education for schools and teachers needs to be strengthened to equip them with the knowledge and skills to cope with the changing needs of students, schools and the community. Hong Kong EC (1997) stated in its Report No. 7 that

> **"There is a need to enhance the quality of present school system. Some schools do not have clear development plans to ensure that the fundamental aims of education are achieved; some do not have clear targets for both academic and non-academic achievement of students; others do not have a proper appraisal system to assess the performance of principals and teachers." (p.x).**

The points mentioned above provide strong rationales of the need for quality school education. In recent years, because of the rapid growth of information technology (IT), in Hong Kong IT is also being explored for its possible contributions to improving education quality. Our Chief Executive, the Hon. Tung Chee Hwa, has pledged to make Hong Kong a leader, not a follower, in the information world of tomorrow (Hong Kong Education and Manpower Bureau (EMB) (1998)). EMB (1998) also stated that " **An important process in pursuit of this goal is the application of IT to enhance the effectiveness of teaching and learning so that our students will be equited with knowledge, skill and attitudes they need to meet the challenges of the information age." (EMB, 1988, foreword).**

Therefore, there is no doubt that information technology plays an important role in Hong Kong in the 21st century in this transitional stage. Thus, applying information technology effectively in the teaching and learning process is a goal in Hong Kong education. However there are still many people who do not agree with EC, who question whether our education today is really not as effective as EC stated (SingTao, 2000). They query whether it is really true that the present educational standard has declined, as EC stated, when compared with the past decades. Nevertheless, there are still many people dissatisfied with the present school education quality, especially businessmen. According to contemporary needs, Hong Kong EC (1997) recommended that in order to strengthen our students' subject knowledge, to enable our students to have independent problem solving ability and be socially-aware adults, schools and teachers have to raise their professional standards. On account of this, EC recommends using benchmark testing as the quality assurance mechanism for assessing teachers' quality. The first benchmark test is set for language teachers. English teachers and Putonghua teachers are required to pass the test by 2005. By schedule, benchmark test for Mathematics teachers may be held in 2007. Besides, teachers also have to pass the IT competency test. Unfortunately, the implementation of the benchmark policy was not as smooth as Government expected. The benchmark policy has received negative reactions from teachers:

> **" The Professional Teachers' Union collected signatures from 36,000 teachers, more than 80 per cent of the total number of primary and secondary school teachers, objecting to use benchmark test as the quality indicator. The Professional Teachers' Union has urged its members to boycott the test. They insist that such benchmark test is an insult to their professions. The union says the test breaches the Basic Law, citing Article 42 which states people with professional teacher qualifications obtained before the handover may retain those qualifications." (South China 2000, p.HK3).**

The union agrees to take further training courses only for teachers' further self-development purposes in recognized institutions. They insist that those courses can't be considered as the tool for assessing their suitability for teaching. For this controversial issue, the researcher has no intention to make any comment on the quality of benchmark tests, on the judgment of selecting benchmark tests as teachers' quality indicator. But, this issue provides a clear picture that both Government and Teachers agree that there is a need to improve teachers' quality. They only differ on the device of improving teacher quality. They both agree that for achieving the restructuring of the economy from manufacturing to a service orientation economy, our children need to equip themselves with knowledge and skills to cope with the changing needs of society. They also agree that Information Technology (IT) will govern our life in the coming future, thus IT knowledge should be integrated in all school subjects. They understand that in order to educate our children with high-level knowledge, to cope with the IT world, teachers should well develop themselves.

1.2 Why Mathematics is Especially Crucial in Preparing Students for The New Century

EMB (1998) warned that while the number of high-skill jobs was likely to increase by the year of 2000, and the number of low-skill jobs decreases rapidly, with the restructuring of the economy from manufacturing to a service and finance oriented economy, in order to cope with the change in labour market demands, the standards and quality of Hong Kong students should be lifted to cope with the future. EMB (1998) understands that for achieving the above-mentioned mission to make Hong Kong become a knowledgeable, creative and generic city, helping students acquire higher-order thinking is crucial. What is the definition of higher-order thinking? Rankin (1991) stated in the Washington Post,

> **" The term 'high-order thinking' was coined by psychologists to describe the process of learning how to learn. Examples of those skills include the ability to find structure in what appears to be disorder, to deal with complex structures and ideas, and to develop multiple solutions. Under this definition, writers, researchers, scientists and educators would count among those who use higher order thinking skills in their work, while those who perform routine, repetitive jobs – the typical factory work of the past – would be less likely to rely on higher order thinking skills."**

How to help students acquire high order thinking? Resnick and Klopfer (1989) emphasize that the entire educational programme needs to be restructured so that thinking skills can be nurtured and cultivated in all students through proper instruction since all learning involves thinking. Kennedy and Tipps (1988) re-emphasize that mathematics is especially crucial because of its central role for developing students' thinking abilities. The Curriculum and Evaluation Standards from the National Council of Teachers of Mathematics (1989) recommends that increased attention should be given to thinking strategies. Essential Mathematics for the Twenty-First Century published by the National Council of Teachers of Mathematics (1989) also provides directives for teaching mathematics in the twenty-first century, which includes mathematical reasoning, problem solving, and higher-order thinking. In addition, Ernest (1989) also stated that there is a growing pressure for innovation in the teaching of mathematics in many countries. NCTM (1980), Cockcroft (1982) and HMI (1985) have made strong recommendations for change including the following:

- **Mathematics teaching needs to focus more on problem-solving, applications and higher level skills.**
- **Mathematics teaching must accommodate the advances in information and microchip technologies, especially electronic calculators and microcomputers, and equip students to make full use of these tools (Ernest, 1989, p. 14).**

Besides, the HKIEd Mathematics Handbook (2001) also states " **Mathematics has an indispensable role in the school curriculum. It is an activity that comprises content and**

process. The contents consist of a body of knowledge that has been developed over the entire history of human thought. The study of mathematics has an intrinsic value, as it can lead to an appreciation of pattern, symmetry, and the beauty of mathematics itself. Students of mathematics can also acquire knowledge of the connections of mathematics to other areas of experience and knowledge. At the same time, Mathematics is a way of thinking and reasoning, and the process of learning mathematics will enable students to develop their generic skills. Doing Mathematics will lead students to develop analytic thinking and problem solving abilities that are very useful in many fields of endeavors. In formulating and solving Mathematics problems, students are encouraged to be creative and to explore different strategies, while the precision and clear expression required by Mathematics will enhance students' communication ability. As the Hong Kong Special Administrative Region (HKSAR) plans to develop as a knowledge-based society, the need for quality mathematics education is clear" (p.160).

Brandt (1988) also concludes that thinking skills can help students to improve their mathematics achievement and mathematics can help students to develop thinking. As Gauss, the famous mathematician, said, " **Mathematics is the queen of the sciences"**. Thus there is no doubt that we can help students acquire higher order thinking skills through mathematics instruction. Therefore, obtaining mathematical skills and knowledge begins in schools and the competency of teaching mathematics becomes a critical factor in the future success of Hong Kong. It is crucial to prepare competent, confident, and resourceful Mathematics teachers who can communicate mathematically, and who can foster their pupils' abilities to explore, conjecture, reason logically, formulate and solve problems. Thereupon, the question ' How to be a competent mathematics teacher?' becomes a major issue in Hong Kong mathematics education and it is the major reason for the researcher to investigate math teachers' teaching competency.

1.3 Why Assess Mathematics Teachers' Subject Content knowledge and Pedagogical Content Knowledge

When we talk about a mathematics teacher's quality in teaching mathematics, it is easy to think that their mathematics achievement is one variable, which relates to a teachers' teaching competency. Schofield (1981), Shulman (1987), Ernest (1989) and Ball (1991) stated that in order to be effective mathematics teachers and teach students well, math teachers must possess both sound mathematics achievement and positive attitudes toward mathematics. What does mathematics achievement define? In their papers, Schofield, Shulman, Ernest and Ball took subject-matter knowledge as mathematics achievement. Thus, subject-matter knowledge can be considered as a measurable performance indicator for assessing teachers' mathematics achievement. In the past decade, teacher's subject-matter knowledge was measured in quantitative terms. It was measured by the scores achieved on standardized tests, by number of academic modules, by number of courses taken in university (Ball, 1991; Shulman, 1987). In Hong Kong, many educators have the same view on taking math subject-matter knowledge as math achievement (e.g. Cheung, 1988). But these quantitative measures do not represent the teachers' entire knowledge of subject matter, especially in the teaching profession, since subject matter knowledge also includes pedagogical content knowledge. In recent years, pedagogical content knowledge has been considered as another category of teacher's subject-matter knowledge. Ball (1991), Shulman (1986) and Ernest (1989) feel that this kind of knowledge can be described as knowing the ways of representing and formulating the subject matter and making it comprehensible to students as well as understanding what makes the learning of specific topics easy or difficult. As teachers' instructional devices influence the process of learning, it is therefore important to understand how teachers explain mathematics knowledge to students, what they emphasize and what they do not; and what ways they choose to help students understand. Although many researchers assumed that teachers' pedagogical content knowledge is influenced by subject–matter knowledge (Ball, 1991; Shulman, 1986 and Ernest, 1989), the interrelationship between the two is not clear enough. For example, Askew et al. (1997) found that " **highly effective teachers of numeracy (can be considered as primary mathematics) themselves had knowledge and awareness of conceptual connections between the areas which they taught of primary mathematics curriculum. In this study, being highly effective was not associated with having an A-level or degree in mathematics. Some, but not all, comparatively less effective teacher of numeracy, including some teachers with high mathematics qualifications, displayed knowledge that was:**

- **Compartmentalized;**
- **Framed in terms of standard procedure, without the understanding of conceptual links" (p. 3).**

Up to the present, there still has been very little research, especially in Hong Kong, studying this correlation among mathematics teachers. Therefore, there are strong rationales to support the researcher to investigate their relation in the Hong Kong context. As most teachers consider pedagogical content knowledge (PCK) as another category of teacher's subject-matter knowledge, in order to make the difference between pedagogical content knowledge (PCK) and subject-matter knowledge (academic) more unambiguous, in this study, the subject-matter knowledge (academic) is replaced by the new term, Subject Content Knowledge (SCK).

1.4 Why Assess Mathematics Teachers' Attitude Toward Mathematics

In the past decade, students' affective characteristics such as attitude, beliefs and self-concept toward subject matter are recognized as important attributes that indicate students' tendency and attainment in studying. There are numerous constructs that reflect these affective characteristics in the usefulness or value of mathematics. McLeod (1992) defined affect as a collection of attitudes, beliefs, appreciation, self-concept, feelings and values. He argued that attitude, beliefs and self-concept should be the most important factors in investigating students' affective domain in mathematics education. He justified these three constructs as follows:

> **"First, students hold certain beliefs about mathematics and about themselves that play an important role in the development of their affective responses to mathematics situations. Second, since interruptions and blockages are an inevitable part of the learning of mathematics, students will experience both**

positive and negative self-concepts as they learn mathematics; these self-concepts are likely to be more noticeable when the tasks are novel. Third, students will develop positive or negative attitudes towards mathematics (parts of the mathematics curriculum) as they encounter the same or similar mathematical situationsw repeatedly" (p.578).

McLeod's constructs of the affective domain in mathematics education are outlined in Table 1.1.

Table 1.1 The Affective Domain in Mathematics Education (Adapted from McLeod, 1992)

Category		**Examples**
1. Beliefs	About mathematics	Mathematics is based on rules
	About self	I am able to solve problems
	About mathematics teaching	Teaching is telling
	About social context	Learning is competitive
2. Attitudes		Dislike of geometric proof
		Enjoyment of problem solving
		Preference for discovery learning
3. Self-concepts		Joy / frustration in solving non-routine problems
		Aesthetic responses to mathematics

Aiken (1980) said that attitude might be conceptualized as learned predispositions to respond positively or negatively to certain objects, situations, concepts, or persons. Mandler (1989) interpreted the coming out of negative attitudes as a result of frequent failures in doing mathematical tasks. Costello (1991) stated, **" positive attitudes can be regarded as valid objectives of mathematics education in their own right" (p.122)**. And Philippou (1998) concluded that repeated self-conceptual reactions result in the formation of an overall schema about mathematics, which becomes a permanent source of beliefs and attitudes. As such, attitude possesses cognitive, affective and performance components. In short, attitude consists of three dimensions: an affective reaction to an object, behaviour towards an object, and beliefs about an object. Thus, it seems reasonable to accept McLeod's (1992) affective categories: beliefs (about mathematics, about self, about mathematics teaching and about social context), and self-concepts in the studying of attitude toward mathematics. Shaughnessy, Haladyna, and Shaughnessy (1983) found that teacher-related variables in attitude had the strongest relationship with students at elementary grades. Watson (1987) and Betz & Hacketett (1989) also found that various teacher attitudes, both directly and indirectly related to mathematics would influence the attitudes of their students toward mathematics. In addition, by formal and informal forums, we have found that there is a general belief among students, teachers, educators and the public in Hong Kong that if student-teachers hold negative attitudes, they are not likely to recognize the similar errors their students make. This would be a negative influence on their students' learning of mathematics.

Besides, in recent years, the relationship between students' mathematics achievement and their attitudes towards mathematics learning has been extensively researched (e.g. Betz & Hacketett, 1989; Drew & Watkins, 1998; Enemark and Wise, 1981, cited in Ma & Kishor, 1997; Fennema & Sherman, 1976; Goolsby, 1987; Kulm, 1980; Lang, 1992; Leder, 1985; Relich, 1996; Spickerman, 1970). Most of them noted that students with a more positive attitude to learning performed significantly better in mathematics than students with a less positive attitude (Enemark and Wise, 1981, cited in Ma & Kishor, 1997; Goolsby, 1987; Lang, 1992; Spickerman, 1970). Since Leder (1985) found that the attitudes of mathematics teachers would affect their students, and students' mathematics achievement are correlated with their attitudes towards mathematics, one important step in improving students' knowledge of mathematics is to improve the attitudes and mathematical competencies of their teachers. Therefore an examination of teachers' attitudes toward mathematics and their mathematical competencies is necessary. Although many researchers have investigated the correlation between students' mathematics achievement and their attitude toward mathematics in primary and secondary levels (Aiken, 1976; Kulm, 1980; Betz & Hacketett, 1989; Cheung, 1988; Fennema & Sherman, 1976; Suydam, 1984), there has been very little research so far in Hong Kong studying this correlation among student-teachers. Therefore, there are strong rationales to support the researcher to investigate whether there is a correlation between attitudes and achievement toward mathematics among student teachers in Hong Kong.

1.5 Objectives

This study attempts to investigate pre-service mathematics teachers' teaching competency in the context of teachers' subject content knowledge, pedagogical content knowledge and attitudes toward mathematics teaching.

More specifically, this study addresses the question, what essential features should a competent mathematics teacher have? Within this context, the researcher is also interested to find out whether differences exist across teachers' programme, gender and age.

1.6 Thesis Outline

In order to achieve the objectives of this study, a variety of instruments are used to measure student teachers' attitude, achievement and their teaching performance. The whole study is structured through the following procedures:

1. To review the main indicators (affective factors) of attitudes toward mathematics and mathematics education for the purpose of identifying particular aspects of attitudes, which are deemed as important in mathematics and mathematics education.
2. To review the measurement of achievement in mathematics and the device of assessing teachers' teaching performance in teaching mathematics.
3. To review methodologies used in studies of attitude toward mathematics, achievement in mathematics and teaching performance in teaching mathematics.
4. To select instruments to collect samples' information about teaching performance, attitude towards mathematics and achievement in mathematics.
5. To test statistically for the relations within their achievement in mathematics and their teaching performance.

Overall, the thesis comprises five chapters.

- Chapter One describes the background and objectives of this study.
- Chapter Two provides the literature review of relevant research studies on attitudes toward mathematics, achievement in mathematics and mathematics teaching performance. The review of literature also develops a framework for this study. Besides, it describes the researcher's focus and what research questions are involved.
- Chapter Three describes the design and methodology used in this study.
- Chapter Four reports the results and statistical analysis of this study. It explains the relationships between subject content knowledge and pedagogical content knowledge; the relationships among attitude towards mathematics, achievement in mathematics and teaching performance in teaching mathematics.
- Chapter Five mainly discusses the research findings. Recommendations, implications and limitations of the study are also discussed. Finally, the conclusion of this study is presented there too.

In summary, this chapter provides the background of the study, reviews the importance of assessing student teachers' subject content knowledge, pedagogical content knowledge and teaching attitude. It also describes the objectives, procedure and overview of the study.

Chapter 2: Literature Review

Over the past 25 years, there have been hundreds of researches, which have dealt with the nature and measurement of attitude (e.g., Aiken, 1976; Armstrong & Price, 1982; Askew et al., 1997; Bell, Brown et al., 1999; Costello & Kuchemmann, 1983; Fennema & Sherman, 1978; Hall & Hoff, 1988; Hart, 1989; Hunt, 1985; Joffe & Foxman, 1988; Nisbet, 1991; Norton, 1998; Relich & Way, 1992; Tocci & Walberg, 1983; Wood, 1988). Research into attitudes has explored various aspects of attitude, such as: relationships between attitudes and achievement, sex differences in mathematics attitudes and achievement, affective variables related to attitudes and various dimension of the attitudes of students and pre-service teachers (e.g., Amodeo & Emslie, 1985; Askew et al., 1997; Brown et al., 1999; Callahan, 1971; Caraway, 1985; Crosswhite, 1972; Edwards, 1972; Evans, 1972; Even, 1993; Fisher, D. & Rickards, T., 1998; Hiebert & Carpenter, 1992; Mastantuono, 1971; Moore, 1972; Norton, 1998; Spickerman, 1970; Whitworth,1979). Over the last two decades, there have been a number of government policy initiatives concerning this issue. For example, the National Council of Teachers of Mathematics (1989) and the National Research Council (1989) have encouraged mathematics educators to incorporate affective factors with cognitive in mathematics teaching and learning; the Australian Education Council (1993) identified sex differences in students' attitudes towards mathematics and a National action plan was prepared for increasing the participation and performance of girls in education, especially in mathematics and science. McLeod (1992) stated that among major descriptors of the affective domâin in mathematics education, attitude, beliefs and self-concepts were the most important factors that would affect student's learning achievement. Ernest (1989) argues that **"official pressure for reforms in the teaching of mathematics overlooks a key factor: the psychological foundation of the practice of teaching mathematics, including the teacher's knowledge, beliefs and attitudes" (p. 13).** The details of these three categories: knowledge, beliefs and attitudes, will be described in the later sections. Askew et al. (1997) also identified effective primary mathematics teachers of numeracy in term of expectations of teacher behaviour, pupil behaviour and pupil learning outcomes. In their studies, they found that **"highly effective teachers believed that being numerate requires: having a rich network of connections between different mathematical ideas; Being able to select and use of strategies which are both efficient and effective" (p.1).**

2.1 Objectives of Review and Descriptors Used in This Literature Review

The aim of this study is to investigate pre-service mathematics teacher's teaching competency in the context of teacher's subject content knowledge, pedagogical content knowledge and attitude toward mathematics teaching. The researcher has no intention to review all factors in the affective domain as they relate to the cognitive domain; this literature review only takes the relationship between attitudes toward mathematics and achievements in mathematics as the major concern. In this study, attitudes toward mathematics are defined as a collection of attitudes including three categories: beliefs, attitudes and self-concepts in mathematics and mathematics education. For primary and secondary students, achievement means academic performance, which is measured by students' results in internal school examinations and public examinations. For pre-service teachers and in-service teachers, their achievements are considered as their teaching competency, and which is indicated by their subject content knowledge (subject-matter knowledge) and its interrelations with pedagogical content knowledge in their teaching of mathematics. Thus the descriptors used in this study were attitude(s), achievement, teaching competence (performance), subject-matter knowledge, pedagogical content knowledge and mathematics. These descriptors facilitated a computer-based search of five databases: Educational Resources Information Centre (ERIC) (1970-2000), PsycLIT (1985-2000), ProQuest (1988-2000), Swetsnet (1988-2000), and Dissertation Abstracts International (DAI) (1985-2000). Besides, the researcher also conducted a manual search, using the same descriptors to search related articles in American Educational Research Journal, British Educational Research Journal, British Journal of Educational Studies, Educational Studies in Mathematics, Journal for Research in Mathematics Education, Journal of Educational Psychology, Journal of Educational Research and School Science and Mathematics etc. Finally the researcher briefly checked references in each selected paper in order to find some relevant information.

The purpose of this review is to provide the researcher with a review of similar researches so that he can synthesize the literature, refine his research questions and develop a theoretical framework for his study.

The review is focused on the following preliminary questions, which are related to attitude and achievement:

(1) What is an attitude?

(2) What major indicators of attitudes toward mathematics are measured?

(3) Do males and females differ in their attitudes toward mathematics?

(4) What are achievements in mathematics?

(5) What is the degree of the relationship between mathematics achievement and attitudes toward mathematic?

(6) What are the most significant research findings on teachers' attitudes toward mathematics?

Based on the above-mentioned questions, Aspects of Review consists of the following four sections.

1. The first section reviews literature on attitudes toward mathematics. The purpose is to understand the nature of attitudes and determine major indicators in measuring student teachers' attitudes toward mathematics.
2. The second section reviews the definition of achievement and the relationships between attitudes toward mathematics and achievement in mathematics. The purposes of it are to have a deeper understanding of the definition of students' and teachers' achievement in mathematics.
3. The third section reviews the research findings of pre-service and in-service teachers' attitudes toward mathematics with the purpose of identifying what factors of attitudes will be selected in this study.

4. The final section describes the researcher's focus relating to the review with the purpose of refining his research questions.

2.2 Attitudes Toward Mathematics

2.2.1 Definition of An Attitude

One of the researchers' most important tasks in the research is to select or develop scales and instruments that are used to measure the required constructs or characteristics. It is obvious that different researchers have different perceptions on what they are going to measure. So, it is essential to consider how the definition and measurement of attitudes toward mathematics has been developed. The rationale is simple: before we know how to measure, we have to know what we are going to measure. As Kulm (1980) stated in his article, the first task in exploring the research done on attitude is to define what is meant by attitude. Thus, the researcher has to define the construct of attitude first before conducting his particular research. What is meant by the term attitude varies among researchers. As shown in the past researches, multiple definitions of attitude have been constructed.

Thomas and Znaniecki (1918, cited in Leder, 1985) in their influential work defined an attitude as a process of individual consciousness, which determines real or possible activities of the individual in the society.

Another early definition of attitude was developed by Allport (1967). He defined an attitude as **"a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individuals' response to all objects and situations with which it is related"(p.8).**

The important features of these early definitions are retained in later definitions of attitude. A definition that includes many of the central ideas used by attitude theorists would be as follows: an attitude is an idea charged with self-concept, which predisposes a class of actions to a particular class of social situations (Triandis, 1971 cited in Leder, 1985).

An attitude is an organization of several beliefs focused on a specific object or situation predisposing one to respond in some preferential manner (Rokeach, 1972 cited in Kulm, 1980,).

Fishbein & Ajzen (1975) stated that attitude could be described as a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object. By these definitions, four crucial assumptions are highlighted as follows,

1. attitude is learned;
2. attitude predisposes to action;
3. the action towards the object is either favorable or unfavorable; and
4. there is response consistency.

During the past twenty five years, instruments commonly used to measure attitudes toward mathematics are for the purpose of reflecting students' cognitive, behavioral and affective components of attitudes to various degrees (e.g. Askew et al., 1997; Betz & Hackett, 1989; Brown et al., 1999; Cheung, 1988; Fennema & Carpenter, 1981; Fenema & Sherman, 1976; Haladyna, Shaughnessy & Shaughnessy, 1983; Ernest, 1989; Hembree, 1990; Hiebert & Carpenter, 1992; Mills, 1993; Norton & Rennie, 1998; Reyes, 1984; Tsai & Walberg, 1983). They distinguished clearly different aspects of students' attitudes toward mathematics and reported the effects of the different components separately. They have realized that there is no unique definition and measurement of attitudes but they still continue to attempt to narrow the gap between different definitions and measurements of attitudes. For example, Leder (1985) rejected the concept of attitudes as ending internal affective predispositions with a causal influence on behavior, or as behavior in their own right. Instead, she defined attitudes as communicative acts, which imply favorable or unfavorable feeling about a class of objects, persons or events. However, researchers still face difficulties in matching the conceptualized components of attitude to their operational definitions and their quantification through measurable aspects of behavior. After studying a great number of related articles, the researcher found that there is little consensus in the definition and construct of attitude. It is impossible to offer a definition of attitudes and a particular construct toward mathematics that would be suitable for all researches and suit all situations. However, the researcher still insists that in order to investigate the relationship between attitude towards mathematics and achievement in mathematics, the researcher must explain as clearly as possible the attitude that a given instrument purports to measure.

2.2.2 Self-Concept About Mathematics

Self-concept has been under investigation for many years. Ross (1992) said that self-concept could influence people's perception of their world and guide their behaviour. Coopersmith (1967) concluded self-concept was the same as self-esteem. He defined self-concept as follows:

> **"The evaluation which the individual makes and customarily maintains with regard to himself; it expresses an attitude of approval or disapproval, and indicates the extent to which the individual believes himself to be capable, significant, successful, and worthy. In short, self-esteem is a personal judgment of worthiness that is expressed in the attitudes the individual holds toward himself. It is a subjective experience, which the individual conveys to others by verbal reports and other overt expressive behaviour" (p.4-5).**

Ma (1997) defined self-concept about mathematics as " **a positive or negative orientation toward one's ability, performance, and the success in the learning of mathematics" (p.91).**

Ma (1997) concluded, " **in the search of the literature on attitude, we came across a variety of issues including self-concept, ... The common interest of researches seems to be in the first three issues.... Therefore, we categorized attitude into self-concept about mathematics and ..." (p.91).**

In fact, the main reason for studying the self-concept factor in students' attitudes to mathematics is to find ways to help students learn more mathematics. Three important affective variables were used in Reyes' (1984) paper for measuring students' self-concept toward mathematics, they are:

1. Confidence in learning mathematics
2. Mathematics anxiety / Attributions of success and failure in mathematics
3. Perceived usefulness of mathematics

Confidence in Learning Mathematics

Confidence influences people's willingness to face new tasks or problems and to persist when the issue becomes difficult. Confidence in learning mathematics was first studied in the National Longitudinal Study of Mathematical Abilities (NLSMA) (Crosswhite, 1972). Confidence in learning mathematics is used to measure the degree to which a person feels certain of his or her ability to do well in mathematics (Norton, 1998). Reyes (1984) identified confidence as one of the most important affective variables because of its strong relationship with achievement. He also identified confidence as one part of self-concept. Cheung (1988) investigated Hong Kong students' perception of their ability to do mathematics. He found that mathematics self-concept was highly correlated with their achievement in mathematics. Crosswhite (1972) reported correlations between confidence in learning mathematics and mathematics achievement scores ranging from .19 to .37.

Later researches have similar results, with slightly larger positive correlations with mathematics achievement in samples from elementary school to college (Armstrong, 1980; Fennema & Sherman, 1976, 1977, 1978). The majority of these correlations range from .3 to .4 for both male and female students. Thus, relatively strong correlations have been found between confidence in learning mathematics (an affective variable) and mathematics achievement.

Armstrong and Price (1982) found that many factors might affect students' participation in mathematics, but that attitudes toward mathematics, including confidence, are important because confidence was the strongest predictor of all the affective variables included in the analysis of self-concepts. Another aspect of research on confidence in learning mathematics is concerned with the mathematics classroom processes of students varying in confidence level. It is hypothesized that students high in self-confidence interact more with their teachers and spend more time on task than students who have lower self-concepts. Some studies support this hypothesis (Shiffler, Lynch-Sauer, & Nadelman, 1977; Yeger & Miezitis, 1980). However, Hart (1989) concluded in her study that some differences are found between the mathematics classroom processes of the high-confidence and low-confidence students, but these differences are neither as consistent nor as pervasive as those between girls and boys. Parsons, Kaczala, and Meece (1982) found that high mathematics self-concept, or confidence, is predicted by high past performance and certain patterns of teacher-student interactions. Students with higher confidence tend to have a higher proportion of interactions yielding praise, higher incidence of work criticism, and lower incidence of criticism after a student-initiated question, and less public feedback after a public error than students lower in confidence. Thus, confidence in learning mathematics seems to be related to classroom processes. However, the relationship is a complex one. Reyes (1981, cited in Reyes, 1984) and Parsons et al.. (1982) both found that classroom characteristics made a difference in the relationship between confidence and classroom processes.

Recently, confidence in learning mathematics emerges as an important component of sex-related differences (Fullarton, 1993; Leder & Taylor, 1995; Haladyna, Shaughnessy & Shaughnessy, 1983; Rowe, 1988; Sherman, 1982). Rowe (1988) stated that **" there is a strong association between achievement and confidence, with confidence being a significant predictor of achievement, especially for students in single-sex classes" (p.195).** Sherman (1982) also found that a considerable proportion of girls in secondary school studied worse in their mathematics classes because of their poor self-concept and lack of confidence in learning mathematics. Fullarton (1993) suggested that girls in Victorian schools in Australia tended to have lower confidence in mathematics by Grade 7.

On the whole, more research is needed in this area, which may have important implications for classroom practice. Recently, confidence in learning mathematics has consistently emerged as an important studying area.

Mathematics Anxiety / Attributions of Success and Failure in Mathematics

Grouws (1992) said that mathematics anxiety has been the topic of more research than any other factors in the affective domain. Williams (1988) concluded that mathematics anxiety may have serious consequences in both daily life and in work, and its formation may be due to poor academic performance in student life. Bush (1989) and Hembree (1990) identified another cause, they felt that mathematics anxiety may come from the ineffectiveness of mathematics teachers' teaching. What is mathematics anxiety? Hunt (1985) described mathematics anxiety as a discomfort feeling or self-concept, characterized by panic, helplessness, paralysis and mental disorganization when confronted with a mathematical problem. Hunt also stated that such constructs appeared to comprise a general fear of contact with mathematics, including classes, homework, and tests.

Mostly, such anxiety comes from the experience of frequent failure in mathematics. Carpenter, Corbit, Kepner, Lindquist and Reyes (1980) reported that 21 percent of the nine year olds pupils they studied claimed that doing mathematics makes them nervous. Hembree (1990) found that mathematics anxiety was not purely restricted to testing. Research into mathematics anxiety has prospered, spurred by increasing perceptions that the construct threatens both achievement and participation in mathematics. Some studies reported higher mathematics anxiety in females than in males (Betz, 1978; Fullarton, 1993; Holden, 1987). Ernest (1976) and Meece, Parsons, Kaczala, Goff, & Futterman, (1982) used enrolment as the indicator of students' anxiety toward mathematics. They found that fewer females than males took part in high school and college mathematics.

The earlier investigation of mathematics anxiety involved various types of research, but most consisted of discussions of how mathematics curriculum and teaching may contribute to mathematics anxiety and descriptions of interventions designed to reduce mathematics anxiety for various groups of the population. But much of the discussion has not been well founded in research knowledge (Reyes, 1984).

The more recent studies on mathematics anxiety are much improved both in depth and methodology. Some important findings can be drawn from them:

a. Positive attitudes toward mathematics are inversely related to mathematics anxiety (Hauge, 1991).

b. "Traditional" manner of teaching mathematics can be the cause of mathematics anxiety and it can be reduced by using nontraditional manner and manipulative materials in teaching (Tobias, 1981 and Schneider, 1988).

c. A consistent, negative relationship has been found between mathematics anxiety and mathematics performance. Higher achievement, success consistently accompanies reduction in mathematics anxiety (Aiken 1970a, 1970b, 1976; Betz, 1978; Clute, 1984; Crosswhite, 1972; Goolsby, 1987; Sarason, Davidson, Lighthall, Waite, & Ruebush, 1960; Szetela, 1973). However, Hembree (1990) reported that there is no strong evidence that poor performance causes mathematics anxiety. Contrary to most research findings, Amodeo and Emslie (1985) concluded in their study that no significant correlation was found between mathematics performance and anxiety level.

d. Betz (1978) found among college students that the number of years of high school mathematics taken "strongly influenced" the level of mathematics anxiety, with the more anxious students having taken fewer high school courses. However, a completely contradictory conclusion has been found by Hauge (1991): the number of mathematics courses taken in high school is positively related to mathematics anxiety, which is contrary to many previous research findings.

e. Treatment can bring back the performance of previously high-anxious students to the performance level associated with low mathematics anxiety levels among males (Betz, 1978; Bretscher, Dwinell, Heyl & Higbee, 1989; Butler & Austin, 1981; Thorndike, 1991). However, females also report higher levels of other types of anxiety than males. It is therefore difficult to separate these results from the known tendency of females to be more willing to report their feelings than males are, and some researchers believe that higher anxiety reported by women is an artifact of this characteristic (Maccoby & Jacklin 1974). Researchers have not yet determined whether differences in reported anxiety are because of true differences in anxiety or not. An interesting finding by Hembree (1990) shows that the higher levels of anxiety do not seem to translate into more depressed performance or to greater mathematics avoidance on the part of female students. In fact, male students in high school exhibit stronger negative behaviours in both of these regards.

Buxton (1981), Byrd (1982) and Reyes (1984) have suggested that it is important for the researchers of mathematics anxiety to attempt to build models or theories that are based on both the psychological and mathematics education research literature, since there are still many questions on mathematics anxiety remaining unanswered. Taylor and Brooks (1986) reported that math anxiety could be reduced by:

- establishing a supportive classroom;
- using manipulative materials to bridge from concrete to abstract;
- using a variety of teaching techniques and
- addressing students' attitudes toward math

Thus, building models or theories for reducing students' mathematical anxiety becomes an important issue for mathematics educators and such kinds of models may take the mentioned findings as the foundations.

Perceptions of The Usefulness of Mathematics

There are many studies that have examined students' perceptions of the usefulness of mathematics. Fennema and Sherman (1977, 1978) found that among middle school and high school students, those who received higher scores on tests of mathematics achievement viewed mathematics as more useful than the lower-achieving students. Armstrong (1980) found similar results with a large nationwide example of twelfth graders. Many researches show that students feel that mathematics is useful in helping them to solve daily problems (Cheung, 1988; Dekkers, Malone, Laeter & Hamlett, 1982; Reyes, 1984). They think that most mathematics has some practical uses and that some knowledge of mathematics is important if a person is to get a good job (Dekkers, Malone, Laeter & Hamlett, 1982). Students recognize the everyday usefulness of mathematics and its importance to society, and can relate mathematical topics to their everyday lives (Joffe & Foxman, 1988; McKnight et al.., 1985). Ramirez (1990) found in his survey that perceived importance of mathematics is the major determinant of mathematics attitudes. Various studies have revealed that students regard mathematics as being of equal or even greater importance compared to other subjects such as English, social studies and science (Corbitt, 1984; Carpenter, et al.., 1980). Overall, students give high ratings to the usefulness and importance of mathematics to society (Mcknight, Travers, Crosswhite & Swafford, 1985).

Several researchers have studied the degree to which students' perceptions of the usefulness of mathematics predict their election of more mathematics courses. Students' choice of mathematics subjects in senior high school is influenced by their perceptions of the usefulness of mathematics, rather than intrinsic rewards from the subject, such as challenge, ease or interest (Cheung, 1988; Thorndike, 1991).

Older students perceive a link between mathematics and future employment or higher education (Bell et al.., 1983; Jones, 1986). Thorndike (1991) claimed that attitudes toward mathematics could be discriminated among students with different career interests. Career plans seem to be an important aspect of usefulness and are strong predictors of twelfth graders' participation in mathematics courses. Other studies also identify usefulness as important in predicting mathematics achievement and course plans (Brush, 1980; Fox, Brody, & Tobin, 1980; Hilton & Berglund, 1974; Thorndike, 1991)). Fennema and Sherman (1977) found that high school students' views about the usefulness of mathematics predict their election of mathematics courses. Those who perceive mathematics as useful tend to elect more mathematics courses. Perl (1979) also found that views about the usefulness of mathematics discriminate between students who elected and students who did not elect to take more mathematics courses.

Though Ramirez (1990) claimed that there is no evidence linking ethnic or socioeconomic background with mathematics attitudes, the results of most studies associated with perceived usefulness are fairly stable. If students' achievement and course plans can be changed by increasing the degree to which they view mathematics as useful, further research will be needed to examine the most potent interventions for different types of students in various settings.

2.2.3 Beliefs about Mathematics

McLeod (1992) found that self-concept and beliefs about mathematics are correlated. As stated in Chapter One, McLeod (1992) identified four categories of beliefs: beliefs about mathematics, beliefs about self, beliefs about mathematics teaching, and beliefs about the context in which mathematics education occurs. But what does the term belief define? Schofeld (1992) defined beliefs as the personal understanding and feeling that individuals have when engaged in mathematics behaviour. Thompson (1992) agreed that beliefs were in systems but such systems are dynamic in nature, undergoing change and restructuring as individuals evaluate their beliefs against their experience. McLeod (1992) justified that:

> **"Students hold certain beliefs about mathematics and about themselves that play an important role in the development of their affective**

responses to mathematics situations" (p.578).

Another aspect of beliefs important to this study is that a student teacher may believe that the key responsibility of a math teacher is to encourage pupils to explore their own mathematical ideas. However, another student teacher might dispute that belief, claiming that the key responsibility is to provide pupils with clear and concise solution methods for mathematics problems. Similar opinion was found in Ernest's paper (1989). Ernest stated in his paper that " **it is possible for two teachers to have very similar knowledge, but for one to teach mathematics with a problem-solving orientation, whilst the other has a more didactic approach. Because of the potent effects of beliefs, like this, the model provides an extensive treatment of the mathematics teaher's beliefs' (p. 20).**

Thus beliefs are highly personal in nature and they will affect teachers' teaching approach and eventually will affect students' learning effectiveness. Brown et al. (1999) also said "**the initial transition from school learner of mathematics to student teacher of mathematics, in this transition, if it is to be successful, must, for many, involve a considerable degree of 'unlearning' and discarding of mathematical baggage, both in terms of subject misconceptions and**

attitude problems" (p.301). Accordingly there is a complex process of learning to teach. That is in line with Hersh's (1986) finding that beliefs about mathematics education, including teaching and learning mathematics, are highly influenced by beliefs about mathematics, especially the conception of what mathematics is. Hersh (1986) stated:

> **"Ones conceptions of what mathematics is affects ones conception of how it shuld be presented. Ones manner of presenting it is an indication of what one believes to be most essential in it...the issue, then, is not. What is the best way to teach? But, what is mathematics really all about " (p.13)?**

Besides, many researches also found that experiences as a learner of mathematics, conceptions about the nature of mathematics and instructional practices as a teacher of mathematics are all strongly interconnected (Thompson, 1984; Lerman, 1990; Lampert, 1988). Hollingsworth (1988) and Bird et al. (1993) also agree that student teachers' pre-program beliefs of mathematics may affect their performance in mathematics teaching. Some even believe that beliefs are fixed before teacher training (Tabachnick & Zeichner, 1986). For examples, Calderhead & Robson (1991) found Primary

BEd students were holding beliefs about teaching which were formed from their previous primary and secondary schooldays. These beliefs were highly influential in their classroom practice and consequently interacting with their teaching performance in teaching practicum and future mathematics teaching. In addition, there are many educators who have investigated the approach of teaching mathematics and teachers' beliefs about teaching (e.g. Collier, 1972; Fullan, 1993; Day, 1996; Thompson, 1984). Thompson (1984) found a high degree of consistency between teachers' beliefs about the nature of mathematics and the teachers' instructional practices. For example, he found that if a teacher's view of mathematics is best characterized as instrumentalist, he or she would teach in a prescriptive manner emphasizing teacher demonstration of rules and procedures. On the other hand, if a teacher views mathematics as a coherent subject consisting of logically interrelated topics, he or she would emphasize the mathematical meaning of concepts and the logic of mathematical procedures in his / her teaching. Brown et al. (1999) also found that among non-specialist primary teacher trainees, there were alternative conceptions of mathematics.

> **"The students' perception can be seen as emphasizing adherence to these alternative conceptions as they encounter changing demands, whether this be**

learning mathematics to pass an examination in school, appreciating the learning task as a student in college, or fitting in to conventional school practices when on a school placement" (Brown et al., 1999, p. 318).

Brown et al. (1999) also claims that these alternative conceptions of mathematics can influence belief, attitude, affect and role from the perspective of the student teacher.

Askew et al. (1997) stated in their report, Effective Teachers of Numeracy, that

" there are three aspects of beliefs which influence the teaching of numeracy:

- **Beliefs about what it is to be a numerate pupil.**
- **Beliefs about pupils and how they learn to become numerate.**
- **Beliefs about how best to teach pupils to become numerate (p.20).**

Unfortunately, many educators found that teachers' beliefs about mathematics or mathematics education were not easily altered once they are well developed in their schooldays; we couldn't expect noteworthy changes to emerge after conducting a single teaching training programme (Collier, 1972; Thompson, 1992). Fullan (1993) also claimed that teachers' beliefs, self-concepts and attitudes were i mportant elements to consider in any change process but it was rather hard to get big changes over the period of conducting a couple of math methodology modules. But McDonald (in McLeod, 1992) reported that students' beliefs about mathematics changed as their mathematics knowledge increased. He also found that students' conceptions of mathematics would change as they grew up, as they learned more math knowledge, as they applied math knowledge in more different situations. McLeod (1992) also concluded that if a student feels confident about doing mathematics and believes that mathematics is nothing more than doing computational work, their beliefs about mathematics as a discipline provide a different perspective regarding their statements of confidence. Besides, Fennema (1990) also found in her research that teachers' beliefs about mathematics would influence their students' learning.

2.2.4 Parental and Social Factors

Several investigators have examined the relationship among social status, family environment, and students' attitudes and achievement in mathematics. Aiken (1972b) found that students' attitudes toward mathematics are positively related to the attitudes of their parents. Yee (1986) claimed that parents strongly influence children's mathematics attitudes and mathematics self-concept, and parents are strongly influenced by teachers' assessments of their children's abilities. Weston

(1969) found that the parents of the children who do well in mathematics are more possessive. Jones (1986) reported that the influence of parents is a strong factor in students' deciding whether or not to take mathematics subjects in year 12. Tsai & Walberg (1983) found significant associations between the attitudes of 13-year-olds and the education of their parents. But, most studies found significant but low correlations between secondary students' attitudes and their parents' attitudes toward mathematics (Bell, Costello & Kuchemann, 1983).

Research by Cain (1986) reported that there is no significant correlation between mothers' attitudes toward mathematics and students' attitudes toward mathematics; however, a significant negative correlation was found between fathers' attitudes toward mathematics and students' attitudes toward mathematics. Implications of a direct influence of parental attitudes upon student achievement are also indicated.

Yee (1984) has explored the strategies parents use to motivate their children in learning mathematics. Results showed that parents from highly conflicted or highly authoritarian family environments rely more on extrinsic motivation practices, while those from highly child self-regulating family environments rely more on intrinsic motivation practices. Parents' preference for certain motivation practices is mediated by their perception of their children's mathematics-related attitudes. This study also found support for the hypothesis that parent-child authority relationships are systematically related to children's self-consciousness in the mathematics classroom. It was concluded that parent-child authority structures are systematically related to parental behaviours and children's self-assessments.

2.3 Sex Differences in Attitudes Toward Mathematics

There is a substantial amount of research concerning differences between boys and girls in their attitudes toward mathematics and their achievement in mathematics (e.g., Benbow & Stanley, 1983; Chipman, Brush, & Wilson, 1985; Fennema, 1984; Fullarton, 1993; Haladyna, Shaughnessy & Shaughnessy, 1983; Hanna et al., 1990; Leder & Taylor, 1995; Norton & Rennie, 1998; Rowe, 1988; Sherman, 1982). However, the results from the literature on gender differences in mathematics attitudes are not often consistent.

Some studies have reported that boys display more favourable attitudes toward mathematics than girls (e.g., Hilton & Berglund, 1974; Kaczala, 1981; Norton & Rennie, 1998). Greater interest and more positive attitudes toward mathematics on the part of boys have been found in various countries, including U.S. (Keeves, 1973; Nevin, 1973;). Significant differences between males and females on mathematics anxiety and attitude toward success are evidenced in some reports (e.g., Bretscher et al.., 1989). Moreover, boys often score higher than girls in confidence in mathematics (Reyes, 1984; Titus & Terwilliger, 1990), and when there is a sex-related difference in mathematics achievement in favour of boys. Lower confidence in learning mathematics and a belief in male dominance in the subject contributed to non-election of mathematics courses by females (Rathbone, 1989). Some studies, however, have reported more positive attitudes toward mathematics from girls (e.g., Haladyna & Thomas, 1979).

There is also evidence not only that male and female attitudes toward mathematics are different, but also that the changes in their attitudes over the grades differ in some ways (Crosswhite, 1972; Fennema, 1974; Hilton & Berglund, 1974). Joffe and Foxman (1988) found significant differences between boys' and girls' attitudes to particular topics in mathematics. Data from a number of sources show that among middle school and high school students, one of the most prevalent sex-related differences in mathematics achievement occurs with high-cognitive-level tasks such as problem solving and application (Armstrong, 1981; Fennema & Carpenter, 1981). Fennema & Carpenter (1981) reported that male students were achieving at a higher level than female students on application tasks even when both these groups of 17-year-olds had taken the same mathematics in high school. When female students achieved at a higher level than male students, it was often on low-cognitive-level tasks such as computation.

2.3.1 Sex Differences and Classroom Environment

Fennema and others have also looked at the classroom environment, investigating the relationship between teacher behaviour and student learning (Fennema & Peterson, 1985). Hart (1989) found that girls and boys who score above the mean in mathematics achievement do participate differently in mathematics classroom processes. More differences between girls and boys were found for the public than for the private teacher-student interaction. Some studies have indicated teachers treat females and males differently in mathematics lessons. Males appear to be more salient in the teachers' frame of reference. Teachers interact with males more than with females in both blame and praise contacts (Becker, 1979, cited in Fennema, 1981). The differences found generally work in a positive way for males, as they received more teacher attention, reinforcement and praise. Females received less of all three (Becker & Hedges, 1984). Fennema (1980) also found that teachers ask males more questions and males are given the opportunity to respond to more high-level cognitive questions than are females. High achieving girls seem particularly vulnerable to teachers' influence. One major study (Good, Sikes, & Brophy, 1973) indicated that high achieving girls received significantly less attention in mathematics classes than high achieving boys. On the other hand, many girls who have been accelerated in mathematics report positive teacher influence as a cause of their success (Casserly, 1980). Becker (1981) tried to explain the phenomenon in her conclusion that first, teachers have different expectations of students based on the sex of those students; second, teachers then treat students differently on the basis of sex in ways consistent with these expectations; and third, students respond differentially in class in accordance with the expectations of teachers and society of their sex roles, with the result that males continue or even increase their active role in class while females tend to react to what they identify as teacher indifference by becoming even more passive.

2.3.2 Sex Differences and Self-Perception

There are also gender differences in self-perceptions and associated behaviours. Studies have suggested that girls score higher than boys on tests of mathematics anxiety (Eccles & Jacobs, 1986). Girls exhibit less confidence in continued achievement in mathematics and are less convinced that mathematics would be useful in their future lives. Some girls may also see some conflict between being able to 'think mathematically' and being female (Fennema & Peterson, 1985). At all mathematical ability levels, greater uncertainty about their mathematical performance is expressed by girls than by boys (Joffe & Foxman, 1984; Leder, 1988; Thomas & Costello, 1988). Furthermore, boys over-rate their performance in mathematics in relation to actual results while girls under-rate their performance (Joffe & Foxman, 1984; Mura, 1987). Dweck (1986) suggested that such differences may contribute to the discrepancies that are found between boys and girls in high levels of mathematical achievement.

2.3.3 Sex Differences and Parental Influence

Parental influences on children's attitudes toward mathematics in the context of gender differences are also explored. Mothers and fathers have different views about their own mathematics abilities, and express different attitudes about mathematics (Yee, 1986). Jacobs (1991) reported that parents' gender stereotypes interact with the child's gender to directly influence beliefs about the child's abilities and that parental beliefs affect the child's self perceptions. Moreover, parents hold sex-differentiated beliefs about their sons and daughters' mathematics achievement even though boys and girls perform similarly on mathematics grades and standardized mathematics tests (Yee, 1986).

Belz and Geary (1984) studied the effect of fathers' occupation on students' achievement. They found that students whose fathers were in scientific, cultural, organizational and outdoor occupations had higher mean quantitative scores on the Scholastic Aptitude Test (SAT). Students whose fathers were frequently absent had lower quantitative scores; girls in this group also had lower verbal scores.

2.3.4 Findings that Contradict the General Notion of Sex Differences

In Parson, Kaczala, and Meece's research (1982), the data does not support the popular notion that sex stereotyping of the subject matter as masculine acts as a deterrent to female achievement. It is suggested by Parsons that females do not aspire to mathematics-related occupations, as they are often stereotyped as decidedly masculine and unfeminine positions. A second measure of sex role identity provided additional support for the idea that it is not the stereotyping of mathematics but rather the range of a student's activity interest that is critical in determining attitudes toward mathematics. Kaczala (1981) made a similar suggestion that although it is likely that an association between gender and student attitudes toward mathematics does exist, other variables such as age probably have greater effect. However, Betz & Hackett (1989) reported that mathematics achievement, parental support and gender are all significant predictors of attitudes toward mathematics. Even after controlling for achievement and parental support, they still found that there are significant gender differences.

Other investigations have reported no significant differences between boys' and girls' attitudes toward mathematics (Aiken, 1976; Hall & Hoff, 1988; Jacobs, 1974 cited in Aiken, 1976; Merkel, 1974; Roberts, 1970), and that some students perceive mathematics to be equally as appropriate for boys as it is for girls (Mcknight et al.., 1985). Rathbone (1989) also concluded in his research that gender is not a statistically significant factor in determining overall students' attitudes. After a detailed meta- analysis of 98 studies on sex differences in mathematical tasks, Friedman (1989) concluded that the average sex difference is in fact very small, and that the sex difference in favour of males is decreasing over short periods of time. Some researchers even stated that no sex differences in mathematics would be found if females were to take the same number of mathematics courses as males (Friedman, 1989). But Gabriele (1993) found an extremely different result. Gabriele conducted a research to evaluate the gender difference in mathematics attitude on a group of 748, aged 14 to 19 German students. He found that there were significant gender differences in many aspects, such as interest in mathematics, importance of high attainment in mathematics, and response to mathematical activities. Though there is evidence that differential coursework accounts for a considerable amount of the sex difference (Pallas & Alexander, 1983; Wise, Steel, & MacDonald, 1979), studies of the general population show that differential course taking does not account for all of the sex differences in mathematical tasks (Armstrong, 1981; Friedman, 1987 cited in Friedman, 1989; Ramist & Arbeiter, 1986).

2.4 Attitude and Achievements in Mathematics

Researchers are especially interested in investigating the relationship between attitudes and achievement. The general hypothesis would be that the relationship is causal such that attitudes are investigated as predictors of achievement. This relation has long been assumed and it was illustrated by Suydm and Weaver (1975) as follows,

> **"Teachers and other mathematics educators generally believe that children learn more effectively when they are interested in what they**

learn and that they will achieve better in mathematics if they like mathematics. Therefore, continual attention should be directed towards creating, developing, maintaining and reinforcing positive attitudes (p.45).”

2.4.1 Students' Achievement in Mathematics

Most research takes students' achievement in mathematics as their academic performance or subject knowledge in mathematics, which is measured by students' results in internal school coursework, tests, examinations, and public examinations (e.g., Brown et al., 1999; Askew et al., 1997; Evans, 1972; Goldstein, 1996; Goulding, 1992; Mastantuono, 1971; Moore, 1972). For example, Askew et al. (1997) identified teachers as highly effective if their classes of pupils had, during the year, achieved a high average score in numeracy in comparison with other classes from the same year group. Thus most teachers prefer to use test or examination results as the indictor of students' achievements in mathematics. Goulding (1992) compared male and female students' mathematics achievement by using different weightings on examination and coursework components. He found that if the weight for the examination component is higher than two thirds to the coursework components, males seemed to perform slightly better than females. But if this weight decreases, the difference between males and females reversed. Joffe and Foxman (1986) reported, " **Males' and females' different attitudes towards learning mathematics were paralleled by differences in the test performance of the two sexes (p.39).**" Besides, some researchers take students' cognitive ability such as intelligence, visual-spatial ability and mental-imaginary power as the predictors of mathematics achievement. For examples, Connor & Serbin (1985) and Tarter (1990) claimed that boys have better achievement in mathematics than girls because they have higher spatial ability and verbal ability and better imaginative power. Leder (1992) also said, "**it was expected to find that males have higher intelligence, stronger visual-spatial skill and richer mental-imaginary power... Nevertheless, there has been no strong evidence to show that male is superior in these cognitive abilities" (p.613-614).**

In view of the literature, researchers' investigated samples can be classified as: primary pupils, secondary students and higher education students. These studies investigate samples of primary (e.g., Evans, 1972; Mastantuono, 1971; Moore, 1972), secondary (e.g., Callahan, 1971; Crosswhite, 1972; Lang, 1992; Norton, 1998; Spickerman, 1970), and higher education students (e.g., Amodeo & Emslie, 1985; Caraway, 1985; Edwards, 1972; Even, 1993; Fisher & Rickards, 1998;

Raymond, 1997; Whitworth, 1979). However, these researches have failed to provide consistent findings regarding the relationship between attitude towards mathematics and achievement in mathematics.

2.4.2 Relationship Between Students' Attitude Towards Mathematics and Achievement in Mathematics

Three types of results about the relationship between students' attitude towards mathematics and achievement in mathematics are summarized by these studies:

1. Most studies have indicated low but significant positive correlation between students' attitudes toward mathematics and their levels of achievement in mathematics. As Aiken (1970a) stated, " **the correlations between attitude and achievement in elementary school, though statistically significant in certain instances, are typically not very large" (p.559).** Correlations found in this type of research were usually around 0.2 to 0.4. This suggests that only a small portion of pupils' achievement can be explained by their attitudes (Aiken, 1980; Anttonen, 1969; Bell, Costello, & Kicheman, 1983; Crosswhite, 1972; Kulm, 1980; Neale, 1969; Suydam, 1984; Tsai & Walberg, 1983; Whitworth, 1979).
2. Results show that attitudes toward mathematics are predictive of final mathematics courses grade (Lang, 1992) and are directly related to both actual

and aspired marks in mathematics courses (Spickerman, 1970), and that the mathematics anxiety score is a good predictor of mathematics performance (Goolsby, 1987). Enemark and Wise (1981, cited in Ma & Kishor, 1997) also demonstrated that " **the attitudinal variables are significant indicators of math achievement"** **(p.22)** and " **a few of the attitudinal variables also showed strong relationship with math achievement even after background and academic orientation variables are controlled" (p. 27).**

3. Attitudes are not significant predictors of performance in a mathematics course (Bassarear, 1986), and no significant correlation is found between mathematics performance and anxiety level (Amodeo & Emslie, 1985). Dungan and Thurlow (1989) have pointed out that there is little evidence showing that favourable attitudes necessarily lead to higher achievement.

These somewhat inconsistent or even contradictory findings may be due to the reason that attitudes interact differently for different groups of students, e.g., male and female, and students of different ability (Bassarear, 1986). It would appear to be most helpful to study the relationship between mathematics attitudes and achievement for different groups in addition to simply comparing group attitudes and achievement means.

The more recent approach attempts to make more sophisticated exploration of the relationship between achievement and various variables of attitudes. Other influential factors are also investigated, for example:

a. Parents' education and home environment have a strong influence on students' performance (Reynolds & Walberg, 1992; McConeghy, 1987).

b. Ethnicity plays a significant role in influencing performance (McConeghy, 1985; McConeghy, 1987; Tsui & Walberg, 1983).

c. Sex is thought to be a less, or even the least, important factor in the relationship between attitudes and performance (Coladarci & Lancaster, 1989; Betz & Hackett, 1989; McConeghy, 1985; McConeghy, 1987; Tsai & Walberg, 1983).

d. Verbal ability and verbal opportunities at home have a strong impact on students' performance (Coladarci & Lancaster, 1989; Tsui & Walberg, 1983).

e. Mathematical background, a mathematics-related major and frequency of mathematical practices also contribute a lot in performance (Caraway, 1985; Cheung, 1988; Coladarci & Lancaster, 1989; Betz & Hackett, 1989; Tsai & Walberg, 1983).

f. The frequency of teacher lectures or explanations is consistently related to both achievement and attitudes such that the greater use of this activity by teachers is related to higher achievement and better attitudes towards mathematics (Hart, 1989).

g. Correlation and commonalty analysis reveal that students' perception of the importance of mathematics to society and the concept of mathematics being a creative subject are strongly pertinent attitude dimensions that related to performance (Cheung, 1988).

Some researches explore the relationship in relation to other population variables as well as to variables in the learning environment. These studies attempted to determine whether attitudes and achievement are affected by a given treatment. Pavlic (1975) investigated whether attitudes and achievement are affected for students in specified mathematics programs. Cohen (1971) deliberately conducted his research in laboratory instructional settings. The exploration on learning environment is aimed at using attitudes and achievement as dependent variables in comparing instructional settings. Attitudes and achievement are compared for different instructional approaches, but their relationship is not clearly explained. Kulm (1980) criticized that the above practice of comparing the effectiveness of an instructional approach with a traditional approach does not provide comparisons of results stated in terms of relationships between variables. A more valuable attempt is by Hart (1989), in exploring the complex relationship between the use of various types of materials and the students' performance. He found that the use of textbooks is related to higher achievement in the four arithmetic operations, whereas the use of teacher-prepared worksheets is related to greater enjoyment and more positive attitudes. Students' use of concrete materials is related to higher achievement on the test and to greater enjoyment, but also to lesser-perceived usefulness of mathematics. Moreover, the frequency of discipline statements by teachers is consistently related, although negatively, to attitudes and achievement.

Some studies show that attitude is somewhat inversely related to grade level (e.g., Callahan, 1971; Evans, 1972), and that the late elementary and early junior-high grades are considered to be particularly important to the development of attitude toward mathematics (Callahan, 1971; Taylor, 1970). A few studies have also looked at the long-term aspects of the general attitudes and achievement relationship (Beattie, Deichmann, & Lewis, 1973; Crosswhite, 1972).

In short, most recent researches reconfirm the earlier finding that the correlation between the attitude dimensions and mathematics achievement are positive, showing that the more positive the students' attitudes towards mathematics, the higher their achievement in mathematics. However, the degree of this correlation still needs to be explored.

2.4.3 Teachers' Achievement in Mathematics

For pre-service teachers and in-service teachers, mathematics achievement is one variable which relates to a teachers' teaching performance. Shulman (1987), Ball (1991) and Even (1993) claimed that mathematics teachers' teaching performance is highly correlated with their achievement in mathematics. What indicators can be used to measure teachers' mathematics achievement? Shulman (1987), Even (1993) and Brown et al. (1999) stated that teachers' subject matter knowledge is a good predictor of teachers' achievement in mathematics. They defined two categories of subject matter specific knowledge involved in the mathematics teachers' subject matter knowledge. They are: subject content knowledge (SCK) and pedagogical content knowledge (PCK). SCK is measured by the scores achieved on standardized tests, by number of academic modules, by number of courses taken in colleges of education or universities (Ball, 1991; Shulman, 1987). Shulman (1987) also regarded pedagogical content knowledge as developed through planning, preparing and teaching lessons and it is "**the special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (p. 8).** Aubrey (1996) described PCK as "**the way mathematical knowledge is presented and the way it is understood by teachers and children in reception classes" (p. 181).**

Even (1993) described PCK as " **knowing the ways of representing and formulating the subject matter that make it comprehensible to others as well as understanding what makes the learning of specific topics easy or difficult" (P. 94).** Besides, Askew et al. (1997) also stated, " **there are three areas together which contribute to what we are calling pedagogic content knowledge:**

- **(Numeracy) subject knowledge: understanding of mathematics and numeracy appropriate to what is being taught.**
- **Knowledge of how pupils learn numeracy: what particular pupils currently being taught understand as well as knowledge of pupils more generally, for example aspects of the numeracy curriculum that are generally found difficult, common misconceptions and models of progression.**
- **Knowledge of numeracy teaching approaches: understanding of teaching styles and difference ways of presenting numeracy ideas to pupils, including a range of**

diagrammatic and verbal representations, so that they gain access to the subject knowledge (p.21).

For beginning teachers, it is not surprising that their PCK is not enough. Since most researchers believe the more limited teaching skills of beginning teachers are due to undeveloped cognitive schemata for pedagogical content knowledge (Feiman-Nemser & Buchmann, 1986, 1987; Livingston & Borko, 1990; Meredith, 1995; Wilson et al., 1987). Meredith (1995) suggests that pedagogical content knowledge presupposes a particular perspective on subject content knowledge and precludes teaching approaches based on different views of the subject. In his case study, student teacher's PCK toward math was drawn upon his beliefs about mathematics, learners and the teaching task whilst learning to teach mathematics. Student teachers seem to acquire pedagogical content knowledge as a result of their own views and prior knowledge being transformed through teaching. Meredith (1995) also suggested that **" representations of mathematics and mathematics teaching, originating in the trainee's own learning, might be concomitant with the development of a particular style of pedagogical reasoning which then determines the type of pedagogical content knowledge that is acquired." (p.175).** Lucas (1993) also agreed that it was difficult for student teachers to translate their subject content knowledge to pedagogical content knowledge for teaching purposes in mathematics teaching. Brown & Borko (1992) obtained a similar result: "**making the transition from a personal orientation to a discipline to thinking about how to organise and represent the content of that discipline to facilitate student understanding is a difficult aspect of learning to teach" (p. 221).** Lucas (1993) also assumed that mathematics student teachers before entering teacher training already have adequate subject content knowledge, but they are unlikely to have well-developed pedagogical content knowledge.

Ernest (1989) argues that **"official pressure for reforms in the teaching of mathematics overlooks a key factor: the psychological foundation of the practice of teaching mathematics, including the teacher's knowledge, beliefs and attitudes" (p. 13).** Hence he addresses this lack by proposing a model of the cognitive structure, the knowledge, beliefs and attitudes specific to the teacher of mathematics. The knowledge component of his model is shown as follows:

> **"Knowledge:**
>
> - **of mathematics**
> - **of other subject matter**
> - **of teaching mathematics: mathematics pedagogy and mathematics curriculum**
> - **classroom organization and management for mathematics teaching**

- **of the context of teaching mathematics: the school context and the students taught**
- **of education: educational psychology, education and mathematics "(Ernest, 1989, p.15).**

In Ernest's model, knowledge of mathematics can be considered as the subject content knowledge of mathematics and which provides an essential foundation for the teaching of mathematics. Ernest (1989) claims that

> **" Whatever means of instruction are adopted the teacher needs a substantial knowledge base in the subject in order to plan for instruction and to understand and guide the learner's response. The teacher's knowledge of mathematics will underpin the teacher's explanation, demonstrations, diagnosis of misconceptions, acceptance of children's own methods, curriculum decision, and so on. Thus knowledge of mathematics provides a foundation for the teacher's pedagogical knowledge and skills for teaching mathematics" (p.17).**

Besides, Ernest divided knowledge of teaching mathematics into two areas, pedagogical and curriculum knowledge of mathematics.

> **"Pedagogical knowledge of mathematics. This is a practical knowledge of teaching. It includes different ways of presenting mathematics including problem-solving; knowledge of children's methods, conceptions, difficulties and common errors; knowledge of mathematical tasks, activities, explanations, test items, and so on. It is this knowledge which a teacher uses to transform and present knowledge of mathematics for teaching" (Ernest, 1989, p. 17).**
>
> **"Curriculum knowledge of mathematics. This includes knowledge of texts and schemes used to teach mathematics, their contents and ways of using them, school produced curricular materials; other teaching resources such as computer software and teaching apparatus, examinations, tests and syllabuses" (Ernest, 1989, p. 17).**

Thus according to the previous definitions of pedagogical content knowledge, in Ernest's model, knowledge of teaching mathematics can be considered as the pedagogical content knowledge of mathematics. The details of the other two components in Ernest's model, attitudes and beliefs, will be discussed in the next section: Teachers' Attitudes Toward Mathematics.

Although Ernest (1989) said "**knowledge of mathematics provides a foundation for the** teacher's pedagogical knowledge and skills for teaching mathematics" (p.17), Even (1993) still emphasized that "even though it is usually assumed that teachers' subject content knowledge and pedagogical content knowledge are interrelated, there is little research evidence to support and illustrate the relationships "(p. 95). Subsequently Aubrey (1996) found that "the range and depth of teachers' own subject knowledge have great influence on teachers' pedagogical subject knowledge and more specifically, on the content and the processes of mathematics instruction"(p.181). In addition, Aubrey (1996) found that " teachers pedagogical subject knowledge will also be influenced by their beliefs about the subject: beliefs about learning and teaching mathematics, about pupils and teachers and subject matter" (p.183). Aubrey (1996) concluded " the tasks teachers set are, thus, a function of feelings and beliefs, interacting with disciplinary knowledge and assumptions about teaching and learning. Such knowledge, beliefs and orientations will both support and limit what teachers do and the flexibility with which they respond. Even if their views of learning change, however, the scope for teaching topics in new ways will be set by the subject knowledge they hold" (p.183).

Aubrey (1996) concluded that "there are relationships among pupils' informed knowledge, teachers' subject content knowledge, knowledge and beliefs concerning learning and teaching, and curriculum knowledge which constitute pedagogical subject knowledge,

and which are exemplified in classroom practice" (p.191). Details of the relationships are shown in Figure 2.1.

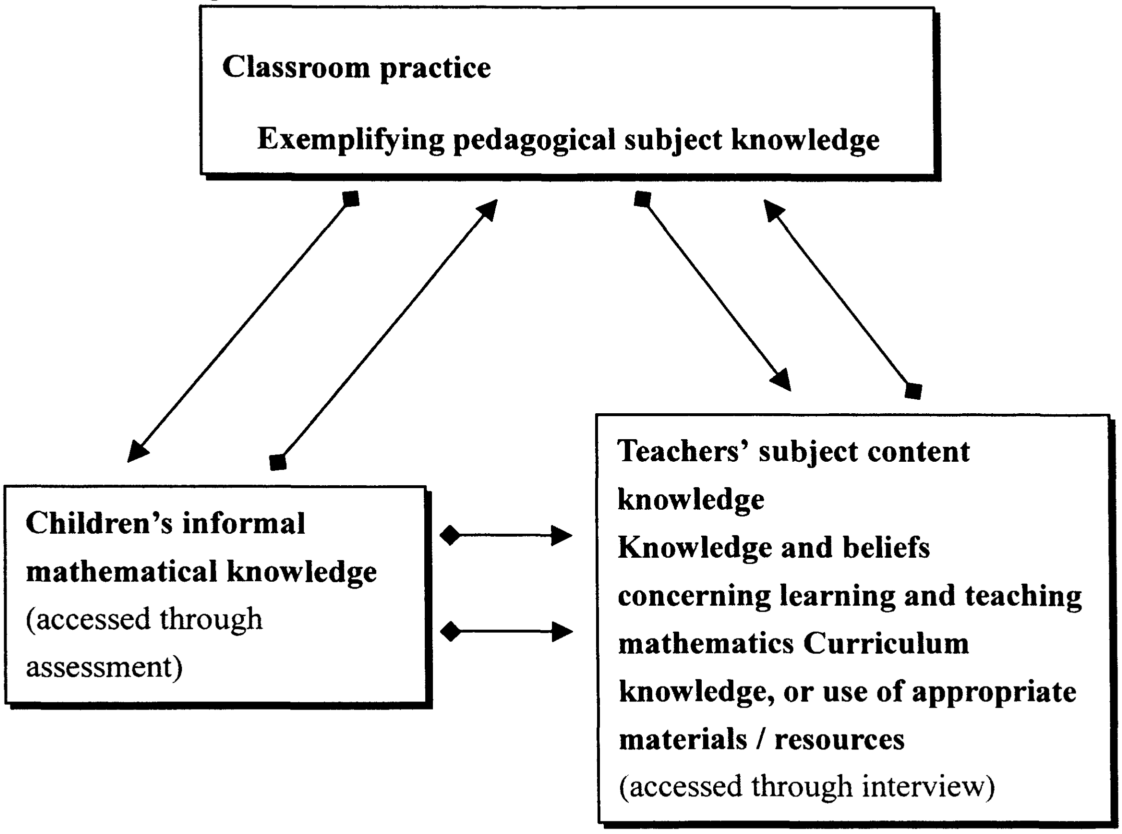

Figure 2.1 The relationships mentioned in Aubrey's study

Carter et al. (1993) had also tried to ascertain the impact of teacher education courses on student teachers' learning, and teaching competency, by assessing the changes in student teachers' subject matter knowledge, pedagogical subject knowledge, attitudes towards subject disciplines and general beliefs about teaching (p.89-90). Generally, Carter et al. (1993) found the courses increased student teachers' self-perceptions of competency to teach as positive statistically significant diffierence was found between pre-and post- assessments. However, Carter et al. didn't clearly distinguish these changes between the influence of the teaching practice component and the taught course, they only stated that they are both important elements to instruct and to provoke reflection. Thus as Carter et al. (1993) stated that " **more research is needed to establish reasons for the changes recorded in these data, and to the particular influences which have given rise to them" (p.95).** Besides, many educators also agree that the development of PCK is the most important and difficult element of achieving to be an effective teacher and it is currently popular in Britain and the USA (McDiarmid et al.., 1989; Grossman et al.., 1989; Brown & Borko, 1992). Hewson and Hewson also found that the thoughts that teachers have about subject content knowledge and about students they are to teach influence the way in which they will teach. Carter et al. (1993) also concluded " **in order to improve teaching, teacher thinking and subject knowledge are deemed to be important ingredients. If these elements are capable of being influenced by teacher education, then research is urgently needed into the efficacy of existing course programme" (p.89).** Besides, educators also found that some new teachers, particularly in primary education, have been observed to lack versatility in this knowledge (e.g. Department of Education and Science [DES] 1988). Thus as a result, how to help student teachers develop their pedagogical content knowledge should be a central focus in math teacher training programmes, and because of no consent made among educators that teachers' subject content knowledge is absolutely correlated with their pedagogical content knowledge, thus it is also worth to have further investigations on the relationship between SCK and PCK.

2.4.4 Teachers' Attitudes Toward Mathematics

Kulm (1980) claimed that prospective teachers have the potential of greatly influencing their future students' attitudes toward mathematics. Shaughnessy, Haladyna, and Shaughnessy (1983) also found that teachers' related variables in attitude have the strongest relationship with students at elementary grades. Watson (1987) also found that various teacher attitudes, both directly and indirectly related to mathematics, would influence the attitudes of their students toward mathematics. Leder (1985) found that the attitudes of mathematics teachers would affect their students' attitudes and students' mathematics achievements are correlated with their attitudes towards mathematics. Therefore one important step in improving students' knowledge of mathematics is to improve the attitudes and mathematical competencies of their teachers. Schofield (1981) also stated that in order to be effective mathematics teachers, teachers must possess sound mathematical competency and positive attitude toward mathematics. Ernest (1989) also argues that in order to be a competent math teacher, besides knowledge, beliefs and attitudes components should be recognized, reemphasized and focused in the teaching training programs. The beliefs and attitudes components of Ernest's model are given as follows:

" Beliefs

- **Conception of the nature of mathematics**
- **Models of teaching and learning mathematics**
- **Principles of education**

Attitudes

- **Attitude to mathematics**
- **Attitudes to teaching mathematics " (Ernest, 1989, p.15-16).**

As Ernest (1989) stated in his paper,

> **"the importance of teachers' beliefs and conceptions concerning subject matter has been noted by a number of authors, both for mathematics (Kuhs & Ball, 1986; Ernest, 1987, 1988; Underhill, 1987; Brown, 1988; Cooney, 1988) and for other areas of the curriculum (Clark & Peterson, 1986; Feinman-Nemser & Floden, 1986). ... The argument is that such conceptions have a powerful impact on teaching through such processes as the selection of content and emphasis, style of teaching, and modes of learning" (p.20).**

Ernest (1989) considered attitudes as a major component in his teaching and learning model which can be described in two aspects: attitudes to mathematics, and attitudes to teaching mathematics. Attitudes to mathematics include: **"liking, enjoyment and interest in mathematics, or their opposites, which in the extreme case can include mathephobia. There is also the teacher's confidence in his or her own mathematical abilities: the teacher's mathematical self-concepts, and the teacher's valuing of mathematics" (Ernest, 1989, p.24).** Attitudes to teaching mathematics include: **"liking, enjoyment and enthusiasm for the teaching of mathematics, and confidence in the teacher's own mathematics teaching ability (or their opposites)" (Ernest, 1989, p.24-25).**

Ernest (1989) came to a similar conclusion to Aiken (1970) who concluded that **"attitudes to mathematics and its teaching are important contributors to a teacher's make-up and approach, because of the effect they can have on a child's attitudes to mathematics and learning....attitudes to mathematics is an affective factor which has a powerful influence on learning" (p.25).**

Askew et al. (1997) found that **"Teachers' beliefs and knowledge and their practice outside the classroom, for example in their lesson planning, will all inform and influence lessons... interaction is not a one way process from teacher to child. Teachers' perceptions of**

pupils' knowledge, understanding and behaviour in lessons will feed back and influence their own beliefs, knowledge and practices" (p.19).

They also emphasized that all aspects stated in Figure 2.2 are not going in one direction. The arrows in the figure indicate the relationships among these factors. Besides, the use of bold arrows in the figure indicates that the strongest effect is likely to be that of teachers' implicit or explicit beliefs and pedagogic content knowledge shaping what happens in the classroom (Askew et al., 1997, p.19).

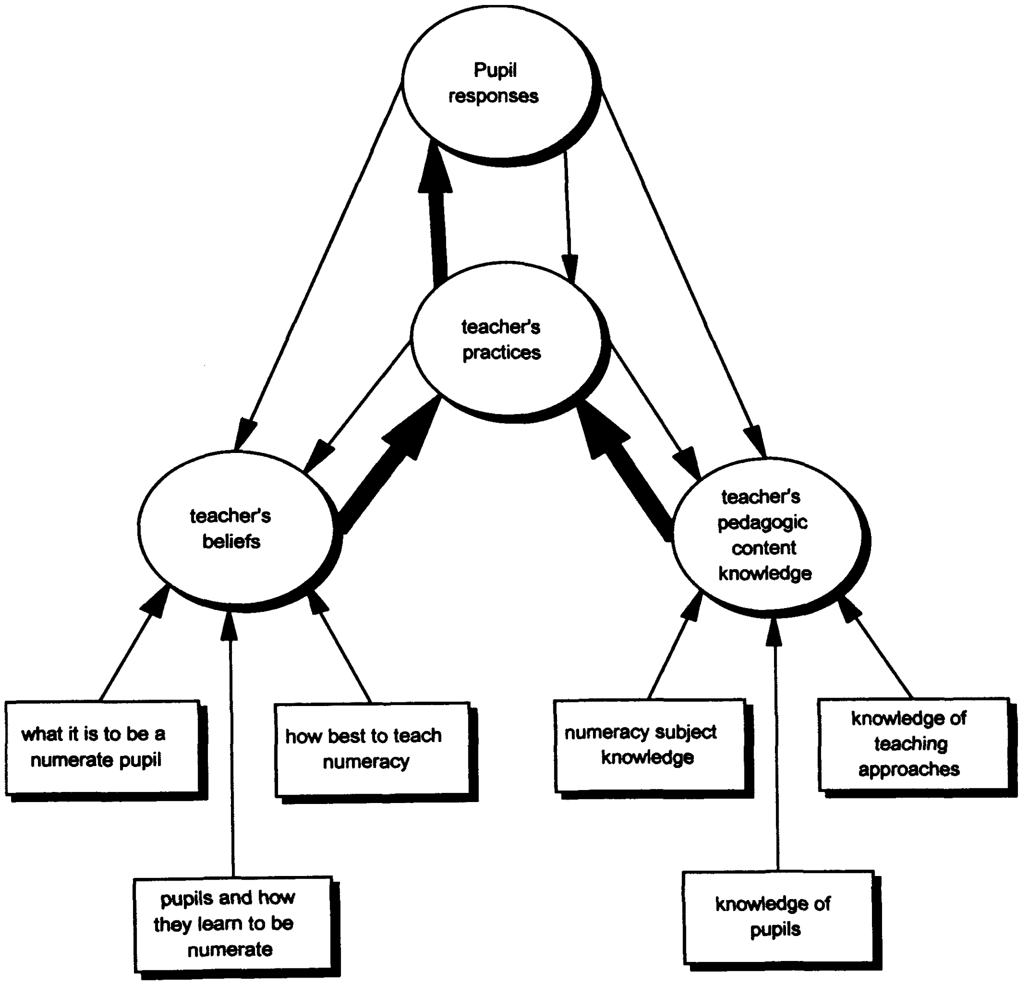

Figure 2.2 The elaborated model

Therefore an examination of teachers' attitudes toward mathematics and their mathematical knowledge is necessary.

Many articles concerning attitudes of teachers were found. Becker (1986) claimed that student teachers, as a whole, are positive in their attitudes toward success in and the usefulness of mathematics. Teachers who prefer to teach primary grades have generally less favorable attitudes toward teaching mathematics than teachers who prefer upper-elementary grades (Early, 1970; Raines, 1971). However, when Clark-Meeks, Quisenberry and Mouw (1982) attempted to see if differences in mathematics attitudes existed among prospective teachers in preschool, early childhood, intermediate, and special education programs, they found that, for the most part, prospective teachers appeared to have unfavorable attitudes towards mathematics and no significant difference among the different groups of sample was evident.

There are many articles that deal with the problems of elementary teachers who are required to teach mathematics even though they are afraid or anxious about the subject (Pearson, 1980; Burton, 1979; Kelly & Tomhave, 1985; Watson, 1987). Kelly and Tomhave (1985) tested a group of college freshmen, including education majors. They found that the elementary education majors scored higher on the anxiety scale than any of the other group except those in the mathematics anxious workshop. They suggested that women elementary school teachers, who constitute the majority of elementary school teachers, may perpetuate mathematics anxiety with young girls in their own classrooms. Becker (1986) investigated the general attitudes toward mathematics of a group of college students, approximately half of whom were education majors. She concluded that it is inappropriate to classify prospective elementary school teachers as having an alarming degree of mathematics anxiety. But, Watson (1987) found a similar result to Tomhave, that first year BEd students enjoy mathematics less than students in a first year B.Sc. course. Even with some improvement in the second year, enjoyment still is less for BEd students. In fact, a study with experienced elementary teachers showed that only 16% would be classified as mathematics anxious and that although there were some differences between women and men, these differences were not statistically significant (Widmer & Chavez, 1982). Chapline (1980) revealed in his study that the teachers who are anxious about mathematics, could clearly link such feelings or attitudes to an individual, negative experience with a particular teacher in their own school careers.

Many studies concerning the relationships between teachers' and students' attitudes toward mathematics have been found, described in the next section, but there are few studies which investigated the relationships of teacher's achievement in mathematics (especially about PCK) and their attitudes toward mathematics. Thus there is a need for further study of this relationship.

2.4.5 Relationship Between Teachers' and Students' Attitudes

Teacher attitudes and qualities have been shown to influence students' attitudes toward mathematics, but mainly for older secondary students (Dungan & Thurlow, 1989). Some studies also have identified links between teachers' attitudes and students' achievement (Hazlett, 1983). Nolan, Archambault, and Green (1976) found that teacher enjoyment of mathematics is significantly positively correlated with students' achievement but not with students' attitudes at the primary level.

Some studies have shown that the effect of teacher attitudes and behaviour on student attitudes varies greatly from teacher to teacher and student to student (Dungan & Thurlow, 1989; Starkey, 1971 cited in Aiken, 1976). Haladyna, Shaughnessy, and Shaughnessy (1983) found that teacher related variables have the strongest relationship with boys' attitude at three grade levels. For girls, teacher variables show the strongest relationships at grade seven but are second to fatalism at grades four and nine. Bell et al. (1983) claimed that students' attitudes are derived from teachers' attitudes, and more favourable teacher attitudes are linked to improved pupil attitudes, although this affects more intelligent students to a greater extent than the less able. Moreover, the encouragement students receive from teachers can influence student selection of mathematics courses (Jones, 1986; Armstrong & Price, 1982).

Phillips' study (1973) gives an interesting result: he found that the children who had connected with teachers with favourable attitudes for at least two out of the previous three years had better attitudes and higher achievement, showing that the impact of teachers' influence may be delayed. Phillip suggested that it is important to consider attitudes of teachers over a period of years when looking for relationships with students' attitudes and achievement.

Specific teacher quality variables, which have been reported to be associated with students' attitudes toward mathematics, include professional activities, overall teacher quality, professional membership and importance of mathematics (Shaughnessy & Haladyna, 1981).

Some studies have found no statistically significant relationships between teacher attitudes and students' attitudes (e.g., Van de Walle, 1973; and Wess, 1970, both cited in Aiken, 1976). Also, some studies concluded that there has been no link established between teachers' attitudes and students' achievement. Aiken (1976) concluded from his research review that no link between teacher and pupil attitudes has been established. Begle (1979) claimed that pupil achievement is not strongly related to teachers' attitudes, background, or concern for their students. Schofield & Start (1978) suggested that no links are established and there are other identifiable factors of more importance. Gitlin (1980) even claimed that teacher attitude scales are of no use in predicting students' achievement and Begle (1979) said that any further research would be a waste of time. On the other hand, Gilbert and Cooper (1976) found a negative relationship between teachers' attitudes toward teaching mathematics and the attitudes of their students. Schofield & Start (1978) also found that higher achievement and more favourable attitudes in teachers were associated with higher achievement but least favourable attitudes in pupils.

2.4.6 Attitude Improvement for Mathematics Teachers

Though some researchers have said that training has little or no impact on teachers' beliefs and attitudes at all (e.g., Bramald et al.1995; Denscombe, 1982; Hogben & Petty, 1979), for example, Bramald et al. (1995) found " **student teachers' knowledge of teaching gained from earlier experience was highly influential in their views on teaching and learning and interpretation of the course, differences between individuals and curriculum groups emerged which suggest that the course of training could not be considered a constant, as had been assumed by earlier studies" (p. 23).** There are also substantial data providing evidence that prospective teachers' attitudes improve over the various stages of their preparation, especially during the methods course (e.g., Collier, 1970, 1972; Erickson, 1970; Sullivan, 1987; Taylor, 1970). Sullivan (1987) explored the issue and found that about half of his sample of beginning teachers had negative attitudes toward mathematics on entering college, and these negative attitudes were mainly among those who had done no year 12 A-level mathematics. At the end of the course the students felt that they were confident about teaching mathematics. The course improved their attitudes but they still had minor negative attitudes at the end. Sullivan suggested that attitudes at the start of training might have had a bigger impact on final attitudes than even the course itself. Watson (1983) went as far as to query whether the improvement in attitudes was a result of the course or natural student maturity. Although this type of improvement usually represents only a change from negative to neutral or slightly positive attitudes, it does indicate that subjects who have a positive motivation to a situation (of becoming a teacher) can change their attitudes toward aspects of it. When an experimental instructional approach in mathematics is compared with a traditional approach, the improvement in attitudes of both groups is usually approximately the same (Beattie, 1970; Drum, 1974; Flexer, 1974; Kontogianes, 1974; McNerney, 1969; Wardrop, 1972; William, 1971). Results of these studies show that experimental methods are not superior to traditional methods with respect to changes in attitudes toward mathematics. Since there are no consensus found in the previous studies about whether training courses have or have little or no impact on teachers' beliefs and attitudes. Thus, the researcher agrees with Bramald et al.'s conclusion (1995) that **" the findings of the study argue that conclusions about the effects of preservice courses on student teachers' thinking about teaching, are too pessimistic and need some refinement ...Further work, therefore, needs to be carried out to understand the variables that influence teachers' thinking so that they can incorporated into course designs, and to identify more accurately the types of students capable of the higher levels of reflection at the selection stage" (p,30).** Besides, it is also important that teacher educators look at the beliefs that student teachers bring with them to the course. Teacher educators should think about how the device or the program can assist or improve students' attitudes toward math teaching once they got the negative attitudes before entering the institute.

2.5 Researcher's Focus Related to Previous Review

From the research literature, we know that changes in attitudes toward mathematics involve a complex interaction among student and teacher characteristics, course content, method of instruction, instructional materials, parental support, and methods of measuring these changes. To reflect the complexity of this area of interests, many of the studies mentioned in the literature review employed multivariate research designs, multidimensional measures of situational and outcome variables. However, there are still many problems which remain unresolved.

The research literature synthesized studies that investigated the relationship between attitude toward mathematics and achievement in mathematics. Those findings are not consistent but most recent researchers still continue to reconfirm their hypothesis that the correlation between the attitude dimensions and mathematics achievement is positive, showing that the more positive the students' attitudes towards mathematics, the higher their achievement in mathematics.

Where findings are inconsistent, it is most likely to be because different samples and different instruments have been used. However, the degree of this correlation still needs to be explored, especially among Hong Kong pre-service and in-service teachers. The rationale is simple: among the hundreds of articles studied, very few have taken mathematics teachers as their study samples. Most research has focused on elementary and secondary students' attitudes and achievements. If we narrow the research to that which has taken place in Hong Kong, there is virtually no research, which has been done on this area. Moreover, the research literature found that the attitudes of mathematics teachers would both directly and indirectly influence the attitudes of their students toward mathematics and also that students' mathematics achievements are correlated with their attitudes towards mathematics (e.g., Leder, 1985; Schofield, 1981; Shaughnessy, Haladyna, and Shaughnessy, 1983; Watson, 1987); therefore one important step in improving students' knowledge of mathematics is to improve the attitudes of their mathematics teachers. Previous studies have used a variety of different instruments to measure students or teachers' attitudes toward mathematics; most instruments used are based on Fennema-Sherman Scales (1976) and only with some appropriate modification. Even for investigating math teachers' attitude toward mathematics, this kind of instrument is still used, focused on attitudes toward the subject of mathematics. Of course, as mentioned in the previous paragraphs, it is worth assessing math teachers' attitudes toward the subject of mathematics but the literature suggests that it is at least equally important to measure math teachers' attitudes toward mathematics teaching. Nisbet (1991) emphasized that **" there should be a distinction between the various facets of mathematical attitude, namely between attitudes to the subject mathematics and attitudes to teaching mathematics ... in order to analyze the attitudes of teachers to teaching mathematics, scales parallel to those identified in the domain of mathematics could be developed" (p.37-38).** Nisbet's instrument has been used to measure beliefs about teaching mathematics rather than the beliefs about the subject of mathematics. For this study, the researcher attempts to use Nisbet's instrument, rather than those instruments which focus only on attitudes toward the subject of mathematics in order to assess the relationship between attitudes toward mathematics and achievement in mathematics. The underlying aim is to identify the implications for training mathematics teachers, which is based on the assumption / hypothesis that math teachers' teaching competency is highly correlated with their attitude toward teaching mathematics.

However, to understand teacher's competency in teaching mathematics, it is also a must to know the teacher's achievement in mathematics (Ball & McDiarmid, 1990;

Hiebert & Carpenter, 1992). Shulman (1986, 1987) said that subject content knowledge (SCK) and pedagogical content knowledge (PCK) should interact in the minds of teachers. Even (1993) described PCK as " **knowing the ways of representing and formulating the subject matter that make it comprehensible to others as well as understanding what makes the learning of specific topics easy or difficult" (p. 94).**

Thus, there is no doubt that the synthesis of SCK and PCK is important to facilitate a teacher's teaching effectiveness. A large proportion of teachers and educators believe that SCK and PCK are highly correlated. They also believe that teachers with better SCK must teach better than teachers with poor SCK. However, Even (1993) emphasized that "**even though it is usually assumed that teachers' subject content knowledge and pedagogical content knowledge are interrelated, there is little research evidence to support and illustrate the relationships "(p. 95).**

In fact, the researcher has encountered some cases where some student teachers in HKIEd with better A-level math results performed less well during their math teaching practice than their classmates with worse public exam results. Therefore it is important to know the achievement in SCK and PCK among mathematics teachers and to explore the relationship between the two. In addition, how teachers evaluate these two sets of knowledge in their mathematics teaching is also a critical problem for researchers when investigating teachers' teaching competency. Thus, the assumption to test is, to be effective mathematics teachers, teachers must possess sound mathematical knowledge, which includes both SCK and PCK, and positive attitudes toward mathematics teaching. However, up to the present, there has been very little research in Hong Kong studying these issues. Therefore an examination of teachers' attitudes toward mathematics teaching and their mathematics knowledge in Hong Kong is necessary.

2.5.1 Research Framework

The framework of this study is mainly based on a quantitative analysis of student teachers' teaching performance and mathematics achievement, which includes Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK), and their Attitude Toward Mathematics (ATM). Figure 2.3 explains the main things to be studied and the assumed relationships among the factors of SCK, PCK and AMT with student teachers' teaching performance.

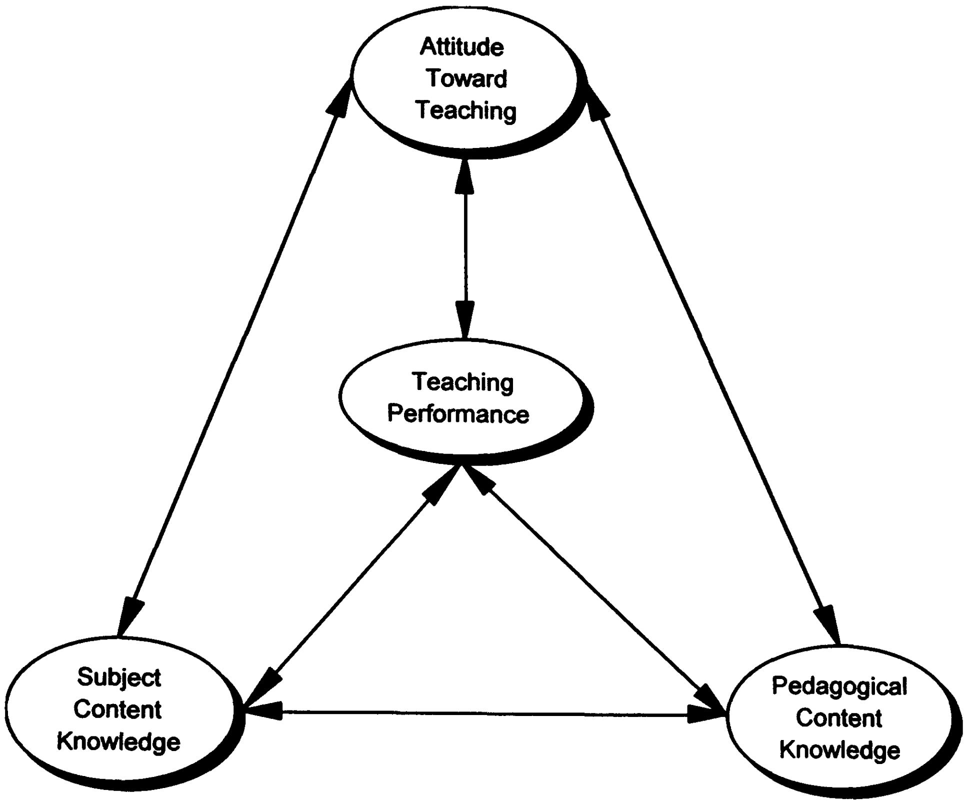

Figure 2.3 Initial framework for the study

2.5.2 Research Questions

The primary research question is: What are the effects of Subject Content Knowledge (SCK), Pedagogical Content Knowledge (PCK) and Attitudes Toward Teaching Mathematics on student teachers' competencies in mathematics teaching.

The related research questions are:

1. Does mathematics teachers' subject content knowledge interrelate with their pedagogical content knowledge?
2. Does this relationship vary across gender and programmes?
3. Are attitudes toward mathematics teaching interrelated with subject content knowledge and pedagogical content knowledge?

4. Do the relationships between attitude toward mathematics teaching and mathematics achievement vary across gender and programmes?
5. Does teaching performance correlate with attitude toward teaching, subject-matter knowledge and pedagogical content knowledge?
6. Do changes exist in student teacher's attitude between pre-TP and post-TP?

The above-mentioned questions form the basis of the following study. Results are then used as a basis for a discussion of directions which student teacher training may consider with the aim of improving student teachers' teaching effectiveness.

Chapter 3: Methods

In chapter one, the background of the study and the contemporary needs of strengthening Hong Kong students' subject knowledge, especially in mathematics are explained. The rationale of investigating the correlation between attitudes and achievements toward mathematics among student teachers in Hong Kong is also described. The study is crucial because teachers' attitudes and their pedagogical content knowledge with respect to mathematics and mathematics teaching could influence their pupils' attitudes toward mathematics and their achievements in mathematics. The aim of the study is to examine the relationship of attitudes toward mathematics teaching, which includes four categories of affective factors: Anxiety, Desire for Recognition, Confidence & Enjoyment and Pressure to Conform, with achievements in mathematics among student teachers in Hong Kong.

In this chapter, the research design is explained. Section One describes the research sample. Section Two describes various methodologies used in the literature and methodologies adapted in the study. Section Three explains the research approach and the instruments used in this study. It consists of the questionnaire used to measure the affective factors about mathematics teaching and teaching practice supervision for the purposes of measuring student teachers' pedagogical content knowledge and overall teaching performance. The research procedure and action plan are described in Section Four. The methods of analyzing data are described in the last section, Section Five.

3.1 Subjects

Previous studies have identified a number of affective factors as having important effects on the relationship between attitudes towards mathematics and achievements in mathematics. However, there has been very little research which took student teachers as the research samples. In addition, geographical, cultural background might influence the findings about the relationship between attitudes toward mathematics, mathematics education and achievement in mathematics. The researcher attempts a further investigation of this issue by taking Hong Kong student teachers as the study samples. This study is mainly quantitative research. A quantitatively based survey was conducted first in order to collect data about samples' attitudes toward mathematics teaching by using questionnaire and then followed by teaching practice (TP) supervision for collecting data about samples' TP performance and PCK levels. Thus, there are two stages: survey and teaching practice supervision.

Background of Samples

Two different programmes' student teachers in the Hong Kong Institute of Education (HKIEd) were sampled. The first programme is a Two-year Full-time Certificate of Education (CE) (Primary) Programme and the second programme is a Four-year Full- time Bachelor of Education (BEd) (primary) Programme. Although both programmes provide students with an understanding of the theoretical foundation of education, the professional skills and general knowledge required of teachers and knowledge of selected academic disciplines related to the primary school subjects, there are differences in programme structure, students admission requirements and also mathematics modules. It is therefore possible that these factors may cause differences in math Subject Content Knowledge (SCK), Pedagogic Content Knowledge (PCK), Attitudes Toward Math Teaching (ATM) and Teaching Practice (TP) performance in math teaching between CE and BEd student teachers. Details of the programme structure and math module charts for these two programmes are described as follows.

Table 3.1 Programme structure for CE and BEd programmes

	Two-year Full-time CE Programme	Four-year Full-time BEd Programme
Programme Durations	Two-year Full-time programme requires at least 60 credit points.	Four-year Full-time programme requires at least 136 credit points.
Admission Requirement	Most students are secondary 7 graduates. For those secondary 5 graduates, they have to complete one preparatory year programme before joining the year 1 programme. ● Math Elective: Grade D or above in a Math subject in HKCEE.	All students are matriculated, secondary 7 graduates. ● Math Major: Grade D or above in a Math subject in AL/ AS examination. ● Math Minor: Grade D or above in a Math subject in HKCEE
Academic Studies Domaim	Students can choose between Double Electives and Single Electives. **Double Electives** (Students may choose one from these subjects): ● Art & Craft ● Computer Studies ● English ● Music ● Physical Education ● Putonghua **Single Electives** (Student may choose two from these subjects): ● Chinese ● Mathematics ● General Studies	Students can choose one major and two minor subjects from the following: **Major:** ● Art ● Chinese ● English ● General Studies ● Mathematics ● Music ● Physical Education **Minor I** ● Chinese ● English ● Mathematics **Minor II** ● Art ● General Studies ● Information Technology ● Music ● Physical Education ● Putonghua
Professional Studies Domain	Including three strands: ● General Education ● Professional Studies ● Field Experience	Including three strands: ● Teaching and Learning ● Educational Studies and Field Experience ● Education Project
Core Mathematics Studies	Students are required to take all the following Core Math modules ● Math Curriculum and Teaching 1 (2 cp) ● Math Curriculum and Teaching 2 (2cp) Introduction to Math (3 cp)	Students are required to take the following Core Math curriculum module: ● General Concepts of Mathematics (2 c.p)

Table 3.2 Mathematics Module Chart for CE and BEd programmes

Year	Two-year Full-time CE Programme		Four-year Full-time BEd Programme		
	Non-Math	Math Elective	Non-Math	Math Major	Math Minor
1	Primary Math Curriculum and Teaching 1 (1 cp) Introduction to Math (3 cp)	Primary Math Curriculum and Teaching 1 (1 cp) Introduction to Math (3 cp) Concepts of Primary Mathematics (3cp)	General Concepts of Mathematics (2 c.p)	General Concepts of Mathematics (2 c.p)	General Concepts of Mathematics (2 c.p)
2	Primary Math Curriculum and Teaching 2 (1cp)	Primary Math Curriculum and Teaching 2 (1cp) The Implementation of the TOC in Math (2cp) *Statistics (3cp) *History of Mathematics (3cp)		Foundation Math (2cp) Curriculum Studies of Primary Math 1(2cp) Concepts in Primary Math (2cp) Elementary Number Theory (2cp) Probability and Statistics (2cp) Elementary Linear Algebra (2cp)	Concepts in Primary Math (2cp) Teahing of Primary Math 1 (1cp) Probability and Statistics (2cp)
3				Discrete Math (2cp) Problem Solving in Primary Math (2cp) Transformation and Geometry (2cp) Concepts of Calculus (2cp) Development of Mathematical Ideas (2cp) Curriculum Studies of Primary Math 1(2cp) Statistical Modelling and its Applications (3cp) Computer-Assisted Learning in Primary Math (2cp) Math Project (3cp)	Problem Solving in Primary Math (2cp) Teaching of Primary Math 2 (1cp) Development of Mathematical Ideas (2cp)
Total cp	5	14	2	34	12

*** Select one only**

Since it is impossible to assign the same lecturer to teach all parallel groups of students in the same module, in order to ensure the quality assurance on teaching, staff present their Module outlines and assessment requirements to students at the beginning of each semester and staff are fully briefed on Modules and assessment details for areas within any Modules for which they are to be responsible. Modules are regularly monitored by ways of staff discussion, student feedback and collegiate sharing. Staff teaching the same subject modules will meet regularly and sometimes informally to share and review their experiences on assessment methods, module design and teaching methods for further improvement and implementation in the next academic year.

In addition, in attempting to ensure the teaching quality, students are encouraged to express their views or comments through other channels, such as the Staff-student consultative meetings, and informal gatherings with their tutors. As well, a central filing system is developed and constantly reviewed so that staff members can easily access any relevant information from the documents relating to teaching, learning, and assessment. There are also module team meetings and informal meetings of staff members to discuss programme-related matters. These meetings can be held very easily since all staff members are located on the same floor of the same building. At the end of an academic year, external examiners for each programme are invited by the Institute to advise on the teaching, learning, and assessment of the programme itself and on the delivery of individual modules. Students' opinions on their own learning are obtained via

(1) the Institute's formal module evaluations,

(2) formal staff-student consultative meetings organised by Programme Committees, and informally by contact with students in person or by some other means, e.g., by email. Because of these procedures, it is reasonable to assume that the teaching quality across different modules and different programmes is largely uniform.

3.1.1 Samples in Stage 1

In stage 1, the participants in the survey are 104 student teachers, all studying in the Hong Kong Institute of Education (HKIEd) and half of whom are taking mathematics as their elective. Of this sample, 52 sampled student teachers are studying in a Two-year Full-time Primary Teacher Certificate Course (CE) and another 52 student teachers are studying in a Four-year Full-time Bachelor of Education Programme (BEd). Of the CE student teachers, 26 student teachers are enrolled as first year students and another 26 student teachers are in the final year of the course. Among them, half takes mathematics as their elective subjects and another half does not. Of the 52 BEd student teachers, also half are studying in first year programme but another 26 student teachers are studying year three. As this programme is the first BEd programme in the Hong Kong Institute of Education and the programme commenced from September 1999, there are no final year students in the academic year 2000-2001. Of this sample, 8 student teachers take mathematics as their major elective (of that cohort, only 8 students take mathematics as their major elective), 18 student teachers take mathematics as their minor elective and the other 26 student teachers come from other electives.

The BEd and CE math elective student teachers are training to be specialist mathematics teachers in the primary school stream and around half of them have the Advance-Level or AS- Level math pass. In contrast, the non-math elective student teachers are training to teach across all academic disciplines in the primary stream, but they still have the opportunity to teach math. Unfortunately, most non- math CE students didn't get any A-level or AS-level math pass; they left school with only a math certificate. Details of group distributions in stage 1 appear in Table 3.3.

Table 3.3 Group Distributions in Stage 1

Courses / Year	4-Yr Full-time BEd				2-Yr Full-time CE			
	Male		Female		Male		Female	
	Math	Non-math	Math	Non-math	Math	Non-math	Math	Non-math
Year 1	5	5	8	8	5	5	8	8
Year 2	n.a.	n.a.	n.a.	n.a.	5	5	8	8
Year 3	5	5	8	8	n.a.	n.a.	n.a.	n.a.
Total	10	10	16	16	10	10	16	16

3.1.2 Samples in Stage 2

Since the purpose of this study is mainly to investigate among student teachers the relationship between achievements in mathematics (including SCK, PCK and TP achievements) and attitudes toward mathematics teaching and also because of time and TP supervision constrains, it is impossible for the researcher to assess all 104 student teachers' PCK and TP achievements. Therefore in stage 2, the subjects of the TP supervision are only 32 student teachers. They are evenly scattered between the two programmes. Details of TP supervision distribution in stage 2 appear in Table 3.4.

Table 3.4 TP Supervision Distributions in stage 2

Courses / Year	4-Yr Full-time BEd		2-Yr Full-time CE	
	Male	Female	Male	Female
Year 1	4	4	4	4
Year 2	n.a.	n.a.	4	4
Year 3	4	4	n.a.	n.a.
Total	8	8	8	8

3.2 Methodologies Used in The Literature and Adapted in The Study

There have been a variety of methodologies used in the literature to investigate the relationships within or between attitudes toward mathematics and achievements in mathematics among students, student teachers or teachers. The following section describes some popular approaches that provided ideas for the researcher to design his research method.

3.2.1 The Attitude Questionnaire

Among the variety of instruments designed for measuring attitudes toward mathematics, the Mathematics Anxiety Rating Scale (MARS) designed by Richardson and Suinn (1972) is widely used to assess the mathematics anxiety of students (Wood, 1988). As well, the Mathematics Attitude Scales

(Fennema-Sherman, 1976, 1980) and the Mathematics Attitude Inventory (Sandman, 1980) are commonly used in the measuring of students' attitudes to mathematics by researchers. Reyes (1984) found that there are several ways students' attitudes to mathematics are related to mathematics learning. Three important affective variables were discussed in Reyes' paper:

1 Confidence in learning mathematics

2 Mathematics anxiety and attributions of success and failure in mathematics

3 Perceived usefulness of mathematics.

The above quotes are a number of researches concerning either primary pupils' or secondary students' attitudes toward subject of mathematics.

From 1980, a number of studies of student teachers' attitudes have been conducted. Sullivan (1987) studied mathematical attitudes of beginning teachers and proposed four dimensions of attitudes to teaching mathematics. They are: Confidence, Liking, Interest, and Ease. Sullivan (1987) reported that about half of the sample of student teachers had negative attitudes to mathematics on entering University. Watson (1987) also found that about twenty-five percents of the Education students felt uneasy, confused, uncomfortable, and nervous about mathematics and about forty percents of Bachelor of Education students appeared to be less than confident with mathematics. Department of Employment, Education and Training (1989, cited in Nisbet, 1991) also pointed out "**there were so many cases reported to the Panel that student teachers entering teacher training programmes do so with feelings of fear and anxiety, and with negative attitudes to mathematics. Thus teacher education programmes will need to give special attention in courses to turn these negative attitudes to positive" (p.66).** The above quotes highlight that a serious problem exists in the aspect of student teachers' attitudes toward mathematics and there is a major task of teacher training institutions to establish student teachers' positive attitudes to mathematics. However, in the above quotes, the instruments used to measure student teachers' attitudes toward mathematics are still mainly based on Fennema-Sherman Scales (1976) and only with some appropriate modification. These instruments only focus on attitudes toward the subject of mathematics. Of course, as mentioned in the previous chapter – (Literature Review), it is worth assessing math teachers' attitudes toward the subject of mathematics but as Nisbet (1991) said, "**in order to study attitudes of student teachers, one needs to identify a number of different facets of mathematical attitudes which influence the behaviour of student teachers – namely attitudes to the subject mathematics education, attitudes to their teaching of the subject, as well as attitudes to the**

subject mathematics itself" (p. 35). Thus it is at least equally important to measure math student teachers' and in-service teachers' attitudes toward mathematics teaching and mathematics education.. Besides, Watson (1987) also suggested that items relating to fears about teaching practice and reasons for disliking mathematics teaching should be involved in the questionnaire. He also stated that there is a need for a scale developed specially for use with pre-service teachers: **" A proposed new scale might very well reflect the factors present in previous scales but it would include statements written in the context of future classroom situations" (p.54).** For these reasons, a new instrument to measure student teachers' attitudes toward their teaching of mathematics is essentially needed. Nisbet also emphasized that **" a more analytical approach to the issue of measuring mathematical attitudes of students is called for. A distinction between the various facets of mathematical attitude, namely between attitudes to the subject mathematics and attitudes to teaching mathematics is required... in order to analyze the attitudes of teachers to teaching mathematics, scales parallel to those identified in the domain of mathematics could be developed" (p.36 - 37).**

Nisbet suggests that the Fennema-Sherman Scales (1976) are most suitable as a base for developing a new instrument to measure student teachers' attitudes toward their teaching of mathematics because they acknowledge factors arising out of previous research, namely gender, enjoyment, confidence, anxiety, motivation, usefulness, and the perception of "significant others' attitudes", such as mother's, father's and teacher's attitudes toward one as a learner of mathematics (Nisbet, 1991, p.38). Taking statements from Fennema-Sherman Scales and altering them to suit the notion of teaching mathematics rather than mathematics per se produced the items for the scales in Nisbet's proposed instrument. Table 3.5 gives details of Nisbet's proposed scales, in attitudes to teaching mathematics, developed in parallel with those in the Fennema-Sherman Scales which focus on mathematics attitudes (Nisbet, 1991, p.39).

Table3.5 Nisbet's Proposed Scales Parallel to the Fennema-Sherman Scales (Nisbet, 1991, p.39)

Scales in Mathematics Attitudes (Fennema-Sherman Scales)	Scales in Attitudes to Teaching Mathematics (Nisbet Proposed Scales)
Confidence in Learning Mathematics	Confidence in Teaching Mathematics
Mathematics Anxiety Scale	Mathematics Teaching Anxiety Scale
Attitude toward Success in Mathematics	Attitude toward Success in Teaching Mathematics
Mathematics as a Male Domain	Mathematics Teaching as a Male Domain
Effectance Motivation in Mathematics	Effectance Motivation in Mathematics Teaching
Usefulness of Mathematics	Usefulness of Mathematics Teaching
Perception of Mother's, Father's or Teacher's Attitude toward one as a learner of Mathematics (3 Scales)	Perception of Mother's, Father's or Teacher's Attitude toward one as a Teacher of Mathematics (3 Scales)

In the factor analysis stage, Nisbet (1991) found that "**Many questionnaire items did**

not serve any useful purpose in analyzing attitudes to teaching mathematics and explaining the variance in the responses. There was an overwhelming consensus of opinion on the items in the " Usefulness" scale, the " Male Domain" scale, two items on the "Effectance Motivation" scale and one of the items of the "Perception of Lecturer's / Teacher's Attitude scale" (p. 44 - 45). Therefore these items were deleted from the questionnaire. In addition, because of the high proportion of responses in the " Undecided" and "No responses" categories, some other items were also deleted from the questionnaire. They are items from the " Perception of Mother's / Father's Attitude " scales (Nisbet, 1991, p.45). Finally, the number of items was reduced from 64 (64 items in Fennema-Sherman's instrument) to 22. Hence, these remaining items are categorized into four factors. They are: Anxiety, Confidence & Enjoyment, Desire for Recognition and Pressure to Conform. A detail of these four factors is shown in Table 3.6.

Table 3.6 Factor Solutions in Nisbet's Study (Nisbet, 1991, p.39)

Factor	Associated Items in Fenneme – Sherman's Instrument
1. Anxiety	1. Generally I feel secure about the idea of teaching mathematics. 2. Of all the subjects, mathematics is the one I worry about most in teaching. 11. I would get a sinking feeling if I came across a hard problem while teaching mathematics at practice teaching. 20. The thought of teaching mathematics makes me feel restless, irritable and impatient. 29. Teaching mathematics at practice teaching makes me feel nervous. 38. The thought of teaching mathematics makes me feel nervous. 54. I'm not the type of person who could teach mathematics very well. 62. Mathematics is the subject I'm least confident about teaching.
2. Confidence & Enjoyment	28. I am confident about the methods of teaching mathematics. 37. I have a lot of self-confidence when it comes to teaching mathematics. 44. I feel at ease when I'm teaching mathematics at practice teaching. 48. I enjoy the challenge of teaching a new and difficult concept in mathematics. 58. Time passes quickly when I'm teaching mathematics at practice teaching. 61. Teaching mathematics at practice is enjoyable and stimulating to me. 63. Teaching Mathematics doesn't scare me at all. 64. I like teaching mathematics at practice teaching.
3. Desire For Recognition	3. It would make me happy to be recognized by other teachers as an excellent teacher of mathematics. 12. I'd be proud to be the outstanding teacher of mathematics amongst my peers. 21. I would like the school pupils to recognise me as a good teacher of mathematics.
4. Pressure to Conform	30. Being an outstanding teacher of mathematics would make me feel unpleasantly conspicuous. 39. My peers would think I was strange if I was an outstanding teacher of mathematics. 45. I would not want to let on that I was good at teaching mathematics.

Nisbet concluded that there are a number of significant features about the results of this factor analysis:

- **The issue of anxiety in teaching mathematics is of utmost importance in attitudes to teaching mathematics. Because anxiety is a major component of such attitudes it should be addressed directly in teacher education programmes.**

- **Anxiety and confidence in teaching mathematics are independent factors. They are not opposite extremes of the one continuum. The most confident students are not necessarily the least anxious.**
- **The nature of the second factor illustrates the close relationship between confidence and enjoyment in teaching mathematics. There is no indication of a cause / effect situation with the two characteristics, merely that the two are closely related.**
- **The third factor reveals a fundamental human need, that of recognition, along with a motivation to be successful at one's chosen career.**
- **Notwithstanding the existence factor 3, there appears to be a strong Australian cultural influence on the students' attitudes to teaching mathematics. Factor number 4 can be denoted as a pressure to confirm or a reluctance to be seen as a "tall poppy" to use the common Australian term.**
- **Where factor 3 could be called attitude toward success (in Fennema – Sherman language), factor 4 could be labeled attitude toward mediocrity (Nisbet, 1991, p.45).**

Nisbet's Teaching Mathematics Questionnaire is mainly developed to measure student teachers' attitudes toward teaching mathematics. The items for the scales in Nisbet's instrument are used to assess student teachers' attitudes toward teaching mathematics rather than attitudes toward the subject mathematics.

Within this instrument, there are some assumptions embedded in each scale / factor.

Firstly, regarding the scale of anxiety, it can be assumed that many student teachers will be anxious about teaching mathematics, but efforts should be made to incorporate into mathematics education courses topics and strategies which can assist in reducing anxiety level. It is reassuring to know that students in their final year of teacher education are less anxious than their counterparts in earlier years. Secondly, regarding the scale of confidence and enjoyment, it is reassuring to know that levels of confidence and enjoyment are higher for final year student teachers. Mathematics education course designers and lecturers should offer opportunities for their student teachers to have experiences which can boost their confidence and provide enjoyment in the context of teaching mathematics to children. For scales 3 and 4, "Desire for recognition" and "Pressure to conform", offer thoughts in term of personal emotional needs of people (not only students) and the social pressures which affect student teachers' attitudes (Nisbet, 1991, p. 48-49).

In this study, the researcher has similar assumptions. For example, the researcher assumes that student teachers in higher years of study are less anxious about teaching mathematics than student teachers in lower years. Thus it is expected that students in the final year in each programme are in turn less anxious than first year students. Similarly, the researcher also expects that student teachers in higher year groups should express greater confidence and enjoyment in teaching mathematics than those student teachers in lower year groups. With this consensus established with respect to the scales of attitudes to teaching mathematics, there is sufficient justification for the researcher to adopt Nisbet's instrument to measure student teachers' attitudes toward teaching mathematics in Hong Kong.

In addition, as Nisbet (1991) said, **"The results reported here can be generalized to other courses, the elements of the new instrument to measure student teachers' attitudes towards teaching mathematics are indicative of significant issues that should be addressed specifically in teacher education programmes"(p.48) and "The object of this attitudes instrument is to enable teacher educators to gauge the attitudes of student teachers towards the teaching of mathematics and to monitor such attitudes during a teacher education programme" (p.49);** by these reasons, the researcher feels that Nisbet's questionnaire can fulfill the researcher's need in measuring student teachers' attitudes toward teaching mathematics in Hong Kong. Thus the instrument chosen in this study is mainly based on the content of Nisbet's Teaching Mathematics Questionnaire (Nisbet, 1991). The format of Nisbet's instrument is described in the next section: the instruments used in the study.

3.2.2 Teaching Supervision / Clinical Supervision

During the past decades, much interest has been shown in investigating the nature and usage of supervision (e.g. Cairns & Ward. 1992; Smyth, 1984a, 1984b; Koballa. Eidson, Finco-kent, Grimes, Kight & Sambs, 1992; Wilhelms, 1973). Research into supervision has focused on various aspects, such as: definition, model and interpretation of the intent and purpose for the adoption and implementation of the process. During supervision, supervisors have to observe and evaluate teachers' teaching performance and diagnose their mistakes. Some supervisors may observe the student teacher's mathematics teaching just for the purpose of assessing the student teacher's teaching performance but fail to give help where and when the student teacher needs it most. This supervisor only takes supervision mainly for assessing rather than determining diagnostic needs. This kind of supervision does little to help the teacher to improve his / her subject knowledge, pedagogical content knowledge and their attitude towards teaching. Thus an appropriate teaching supervision should be two-fold, one for assessment purposes, one for diagnostic and preventive purposes. What supervision can fulfill these purposes? Clinical supervision.

The following description provides a comprehensive review of the literature on Clinical Supervision. The purpose is to provide some viewpoints for the researcher to adopt in his particular study.

Definition of Clinical Supervision

Wilhelms (1973) stated that **"the term 'clinical ' refers to the in-class nature of assistance provided to teachers to help them make sense of the complex processes of teaching and learning; in short, it has to do with discussion, observation, and analysis ' in the clinic of the classroom' " (p.ix).** The word 'supervision' as Cogan (1973) described it, is a process in which teachers worked supportively with each other in dialoguing, proposing hypotheses, and analyzing their own and each other's teaching. Generally, clinical supervision can be defined as a collaborative process whereby teacher and supervisor work together for instructional improvement by means of systematic cycles of discussion, observation and analysis (Henderson & Lampe, 1992; Smyth, 1984a). As Turney et al. (1982) stated, clinical supervision is concerned with facilitating the learning and teaching process so that clinical supervision would benefit both teachers and students. Another aim of the supervision process will be the development in student teachers of concern for and skill in self-supervision-autonomy in planning, analyzing and improving teaching performance for themselves (Greene, 1992).

Models of Clinical Supervision

There are three major models used for the purpose of conducting clinical supervision. The first one is developed by Goldhammer (1992). Cogan (1973) and Acheson & Gall (1980) modified this and developed another two models. Goldhammer's four stages, Cogan's eight phases and Acheson's and Gall's three phases are presented in Table 3.7.

Table 3.7 Summary of The Process of Clinical Supervision

Goldhammer (Stages)	Cogan (Phases)	Acheson & Gall (Phases)
1. Pre-Observation	1. Establish Relationship	1. Planning
Conference	2. Planning with Teacher	
	3. Planning and Observation	
2. Observation	4. Observation	2. Classroom Observation
3. Analysis & Strategy	5. Analysis Session	
	6. Planning Conference Strategy	
3 Supervisory	7. Conference	3. Feedback Conference
4 Conference	8. Renewed Planning	

3.2.3 Clinical Supervision for Pre-Service Teachers in Hong Kong

In recent Hong Kong teachers' training programmes, student teachers have to pass the practice teaching before getting their certificate. This kind of practice teaching has similar characteristics to Acheson's and Gall's three phases of clinical supervision. For example, in Hong Kong Institute of Education, the practicum is a part of the Certificate in Education Course (CE) and Bachelor of Education Programme (BEd) where the student teacher has the opportunity to bring together all that he / she has been learning about teaching and the elective subject content knowledge and pedagogical content knowledge and see how they can perform in their classroom teaching. The practicum is recommended to be approached through a three-phase cycle of conferences and observation. It is adapted from Acheson & Gall's 3-phase model. This cycle is:

Planning Conference ➔ Observation ➔ Feedback Conference

Phase 1: Planning Conference

This conference should be held before the practicum. The lecturer and students should discuss the content of lesson plans, some instructional procedures and the expected response of pupil. The lecturer also needs to explain the lesson analysis form (teaching appraisal form), which is designed by the Institute. It is used for a ' wide lens' view of the student's work. Besides, this teaching appraisal form may also be used to predict student teachers' strengths and weaknesses in future teaching.

Phase 2: Observation

The main task of the supervisor (supervising lecturer) is to collect data on the student teacher's practicum teaching. These data usually will relate to the general teaching behavior proposed by the lesson analysis form but may be more specific if the supervising lecturer and the student so agree in the planning conference. For example, if a first year mathematics student teacher is concerned about the phrasing of questions, the observer might simply write down the questions the student teacher asks word by word for the purpose of analyzing his or her questioning strategies. But for BEd year 3 students, they may be requested to integrate information technology or teaching aids in their teaching. Thus the supervisor may focus on the assessment of their designs, preparations and presentations of their planning. Therefore, this supervision emphasizes their PCK rather than their SCK.

Phase 3: Feedback Conference

After the lesson the supervising lecturer should share the collected data with the student. They should analyze the data, diagnose mistakes and make plans for the next observation. The student should be encouraged to share the opinions and feelings aroused by the data. The supervisor may give the student opportunity to practice specific behavior in the next observation. Thus the aim of the feedback conference is to improve the student teacher's teaching, to overcome his or her mistakes, to improve his / her attitudes toward math teaching and enrich their PCK levels. The supervision process used in this study is based on this 3-phase model and details of the teaching appraisal form will be described in the next section: Instruments used in the study.

After completing the whole TP supervision, those student teachers selected for this study are requested to re-answer the attitude questionnaire again in order to assess whether differences exist between the pre- and post TP. Hence their TP performance and PCK results will then be used for statistical analysis.

3.2.4 Correlational Research

After reviewing a variety of instruments and activities designed for collecting the sample's attitudes toward mathematics teaching, achievements in mathematics and mathematics teaching performance in the literature, this section discusses various methods which might be used for analyzing the collected data. Generally in the past three decades, many researchers like to use some kinds of inferential statistical tests for analyzing sample's responses to the questionnaire. Up to the present such statistical analysis is still considered as an effective tool for analyzing quantitative data. For example, Aiken (1976) used the statistic r, Pearson's Product-Moment Correlation Coefficient, to measure the relationship between the attitudes towards mathematics and achievements in mathematics under the effect of gender. Aiken (1976) found that " **girls' mathematics marks are more predictable from their attitudes than boys' marks" (p.296)** because the correlation between attitudes towards mathematics and achievements in mathematics is **" generally somewhat higher for girls" (p.296).** Later, Aiken (1976) also reported that **" a low but significant positive correlation" existed at primary and secondary school levels (p.295),** and that **" the correlation between attitude and achievement varies... with grade level" (p.296).** There is no doubt that the Pearson Correlation Coefficient is useful to reflect the strength and the direction of association between variables and the degree to which one variable can be predicted from the other. For another example, Watson (1987) found that **" the relationship between achievement and belief in the value of mathematics was considerably less strong" among preservice primary teachers in Australia (p.52)."** This reflected a value of r of 0.113, although he didn't explain the interpretation of this value. Once we convert it into a percentage, the value of r equals 0.113 indicates that it is only around 1.27 percent (0.113^2) of the variation of achievement in math (variable y) that is accounted for by a linear relationship with attitudes toward math (variable x). If we plot x and y on a graph, the points are random-scattered. That is the reason why Watson (1987) concluded that **" the**

relationship between achievement and belief in the value of mathematics was considerably less strong (p.52)." In other words, there is virtually no relationship. Similar in approach are studies which investigate differences between groups, using such statistical tests as chi-square and t-tests (eg. Perry, Howard & Conroy (1996) and Watson (1988)). Relich, Debus & Walker (1986) said that there is no doubt that correlational studies can be supportive in investigating the role of self-efficacy between attitude variables as an exogenous variable and a mathematics performance measure as an endogenous variable. However, others have found it was necessary to use multivariate and other more complex technique such as factor analysis (e.g. March (1994) and Nisbet (1991)) and meta-analysis (e.g. Marsh (1995)).

Furthermore, it is not enough if the research uses only a survey to investigate affective factors and achievements in teaching mathematics. The major reason is that some factors and information cannot be directly collected or interpreted by means of using self- assessed survey. Thus many researchers prefer to have some observation instruments to supplement the deficiency. The most useful approach is case study. Therefore, in this study, there are two stages: survey and teaching practice supervision.

3.2.5 Direct Observation Vs Self-report Questionnaire

Much descriptive research is based upon self-report evidence. That is, the subject tells you about himself or herself. For example, in studying student teachers' teaching behavior in their teaching practicum, relevant aspects include: student teachers' teaching confidence & enjoyment, teaching strategy, facial expressions and hand gestures etc. In addition, we want to know whether there is any correlation between concept presentation and their level of confidence. In the case of self-report questionnaires, the subject is asked to report self-perception of their own performance; they are requested to answer a set of self-evaluation questions. The department of mathematics, the Hong Kong Institute of Education develops those questions. Each of the measures will be registered on a 5-point scale, 1 being the extreme negative, 3 neutral, and 5 the extreme positive. Table 3.8 presents the content of self-evaluation questions.

Table 3.8 presents the content of self-evaluation questions.

Thinking back to when you finished the lesson, how did you feel about your teaching confidence?				
very weak	fairly weak	average	quite good	very good
How did you feel about your teaching performance, concept presentation?				
very weak	fairly weak	average	quite good	very good
How did you feel about your teaching performance about Questioning strategy?				
very weak	fairly weak	average	quite good	very good
How did you feel about your teaching performance on designing and using teaching aids?				
very weak	fairly weak	average	quite good	very good

Walter (1981a) stated that a serious potential weakness of self-report measures is that the subject may tell you only what he wants you to know. Thus such evidence may be distorted or subject to omission. When using self-report evidence, the researcher must recognize this danger and be alert to avoiding what might lead the individual to provide inaccurate information. Even if the subject wants to give accurate information, he may lack the insight to do so. For example, research has shown that self-ratings on many variables differ considerably from ratings of the individual by others. If the study is in any way threatening to the subjects, if any feel that honest answers can harm them, or if the questions call for a level of insight that the subjects may not possess, you can assume that many subjects will lie or give inaccurate answers. In this study, TP is considered as a crucial factor, which will affect student teachers' studying progress. Once student teachers fail their TP, they can't continue to higher years. They have to pass the supplementary TP, which will be arranged in the early part of the next September. Moreover, a self-report questionnaire only provides point scales measures, it doesn't describe the teaching picture in detail. Due to the lack of description of mis-conception or mistakes made by the teacher, it is hard to make a diagnostic evaluation. Thus if the whole supervision and the data about student teachers' PCK and TP performance are based solely on student teachers' self-reflection, self-report, it can't help the student teacher to discover and overcome their mistakes or mistakes made by the teacher. It is hard to help them to improve their teaching effectiveness. The data collected won't be accurate enough. Because of the weakness of self-report evidence, the researcher has made increased use of direct observation of the subjects' PCK and TP performance. Thus, direct observation is essentially a technique for gathering data about the subjects involved in this study. The great advantage of the observational process is that it enables the researcher to collect direct information about student teachers' PCK, teaching performance and affective behaviors (e.g. teaching confidence, beliefs about math).

In summary, direct observation is especially effective in situations where the researcher wishes to study specific aspects of human behavior and this study's major objectives are to investigate "how" affective factors effect student teachers' teaching performance and "how" student teachers' views of mathematics subject content knowledge (SCK) and pedagogical content knowledge (PCK) relate to their teaching performance. Therefore direct observation is an appropriate instrument in this study and is practiced by the researcher's observation of the students' teaching practice.

3.2.6 Path Modeling Approach

Besides using traditional approaches in investigating the relationships among the affective factors, another approach, path modeling is proposed as a useful model to explain the relationships among affective factors with respect to mathematics and mathematics education. Pajares and Kranzler (1995) developed a path model that included math anxiety, math self-concept, math self-efficacy, gender and previous grades in math. The model effectively explained the interrelation among these affective factors. Later, Pajares (1996) modified their previous model, and used path analysis to analyze the role of self-efficacy beliefs in mathematical problem solving. His path model is shown in Figure 3.1.

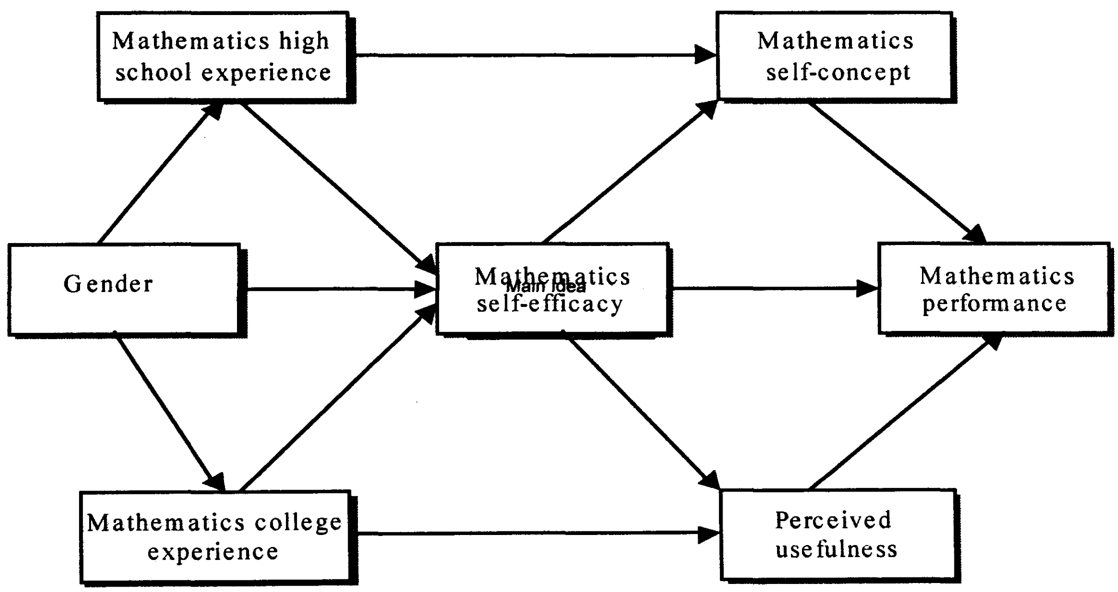

Figure 3.1 Mediational role of self-efficacy in mathematical problem solving (adapted from Pajares, 1996)

Pajares (1996) found that in the study of gifted students in his path model, mathematics self-efficacy made an independent contribution to the mathematics performance, especially for math problem solving, if the effects of math anxiety, math grades, cognitive ability and gender were under control.

" Path analysis is a technique that uses both bivariate and multiple linear regression techniques to test the causal relations among the variables specified in the model. It involves three major steps:

1. **The researcher draws a path diagram based on a theory or a set of hypotheses.**
2. **The research then calculates path coefficients (direct effects) using regression techniques.**
3. **Finally, the researcher determines indirect effects (Nachmias & Nachmias (1996), p.448)."**

In summary, path modeling is useful in studying the affective domain with respect to mathematics education. It can be used to explain the relationships between affective factors and achievement in mathematics. However, path analysis involves substantial, complicated statistical analysis by calculating path coefficients using regression techniques. In fact, it is hard for primary teachers to interpret its concepts and the meaning of path coefficients. Thus the researcher decided only to adopt the concept, continuing to use a path diagram to present the interrelations among student teachers' affective factors, SCK and PCK, but the formation of the paths is not based on the techniques of constructing multiple regression lines. In this study, analysis of quantitative data will be the foundation for constructing the framework of relations among affective factors and achievements in math in the form of a diagram.

3.3 Research Procedures and Action Plan

This section aims to provide a brief description of the process of the study. The study preceded under 7 stages. Table 3.9 shows these stages and the action plan of the study.

Table 3.9 The Action Plan of The Study

Stages	Content	People Involved	Timeline
1	Literature Review	Researcher	Nov. 1999 to Mar.2000
2	Development of Instruments ● Questionnaire of Attitudes ● Semi-structured interview Questionnaire ● Probing Questions and pupils' Misconception Problems	Researcher	April 2000 to July 2000
3	Administration of Questionnaires and organizing collected data	Researcher, 52 BEd Student teachers and 52 CE Student teachers	Aug. 2000 to Jan. 2001
4	Observing Teaching Practice	Researcher, 16 BEd Student teachers and 16 CE Student teachers	Feb. 2001 to April 2001
5	Re-do Questionnaire of Attitudes	Researcher 6 BEd Student teachers and 6 CE Student teachers	Feb. 2001 to April 2001
6	Data Analysis	Researcher	April 2001 to June 2001
7	Drawing Conclusion	Researcher	July 2001 to August 2001

3.4 The Research Approach and Instruments Used in The Study

3.4.1 Research Approach

The design of this study is mainly quantitative. It includes:

- Survey: using questionnaire to collect samples' attitudes toward math teaching and attainment in math (SCK).

- Case study: including direct TP observation and post TP discussion for the purpose of collecting samples' PCK level and assessing their math teaching performance.

Quantitative data includes information collected by questionnaires and the converted score from teaching practice supervisions. Case study includes observing teaching practice, assessing student teachers' lesson plans and their written self-reflections. This study requires many student teachers' responses. Therefore, the data collected by questionnaire and TP observation can triangulate and supplement each other and clarify the views, beliefs and attitudes of the participants. The instruments chosen in this study are explained in the following section.

The survey was conducted at the beginning of the academic year 1999 and followed by case studies across the end of 1999 to the early May of 2001. Using statistical analysis and by analyzing case studies a path diagram has been constructed to explain the relationships among affective factors, mathematics subject content knowledge (SCK), pedagogical content knowledge (PCK) and student teachers' teaching performance.

3.4.2 The Instruments Used in The Study

Attitude Questionnaire

The instrument for measuring student teachers' attitude to mathematics was mainly based on Nisbet's Teaching Mathematics Questionnaire (1991). Nisbet's instrument is designed to measure teachers' attitudes towards teaching mathematics rather than subject mathematics and it is presented in **Appendix A**. In Nisbet's Teaching Mathematics Questionnaire, there are four factorial scales used to measure teachers' beliefs, self-concept and attitudes toward mathematics. They are: Anxiety, Confidence & Enjoyment, Desire for Recognition and Pressure to Conform. The scales have a high degree of reliability ranging from 0.71 to 0.89. They are calculated by Spearman-Brown coefficients:

Anxiety scale:	0.80	Desire for recognition scale:	0.71
Confidence & Enjoyment:	0.89	Pressure to Conform:	0.74

The questionnaire consisted of two parts:

Part 1

General Information. It includes some information about age, sex, enrolled programme and the highest level of mathematics in public examinations that the respondents achieved before entering the Hong Kong Institute of Education. This information provides an overview of the respondents' background. In addition, they are useful for the analysis of other statistics with regard to sex, age, enrolled programme and the performance of mathematics teaching.

Part 2

A set of 22 statements in four attitudes scales expressing positive and negative opinions about teaching mathematics (see Appendix A). These 22 items require Likert type scale responses on a continuum from 1 to 7.

1 means disagree strongly

2 means disagree generally

3 means disagree a little

4 means undecided

5 means agree a little

6 means agrees generally

7 means agree strongly

Pretesting the Questionnaire: 5-Point Scale vs 7-Point Scale

Once the questions to be included in the questionnaire had been written, the researcher tried them out with two student teachers similar to the potential samples. By the 'pretest' of the questionnaire, the researcher discovered that the instructions given to the respondents were clear and no poorly worded questions existed. Although all questions are written in English, the two-pretest respondents could fully understand all questions. But because the scoring scale used in this questionnaire was the same as in Nisbet's original study, on a scale of 1 to 7 from "strongly disagree" to "strongly agree", the researcher found that among 44 responses, no choice fell either on 1 (disagree strongly) or 7 (agree strongly). After considering this ambiguity, for each response to the statements in the questionnaire, a 5-point scale is used instead of the original 7-point scale.

1 means disagree strongly

2 means disagree

3 means undecided

4 means agree

5 means agree strongly

Hence a "neutral" response for each statement would be represented by point 3. Thus, the neutral response to the attitude to teaching mathematics would produce a total score of 66. If the sampled student teacher has a total score less than 66, it means she or he has a negative attitude toward teaching mathematics. A total score more than 66 indicates a more positive attitude toward teaching mathematics. In order to minimize the probability of guesswork or of random answers, some opposing statements were devised in the questionnaire. For example, in the confidence scale, statement number 1 was " Generally I feel secure about the idea of teaching mathematics" whilst statement number 15 was " I would not want to let on that I was good at teaching mathematics". Thus among 22 statements in the questionnaire, some statements are negatively oriented and some are positively oriented. More examples are as follows:

Negatively oriented items-

2. Of all the subjects, mathematics is the one I worry about most in teaching.

9. Teaching mathematics at practice teaching makes me feel nervous.

Positively oriented items-

8. I am confident about the method of teaching mathematics.

10. I have a lot of confidence when it comes to teaching mathematics.

Thus for analyzing the negatively oriented items, point values were reversed.

Administration of The Questionnaire

The questionnaire was administered to two courses of student teachers twice, one in the period between late October and early November in 1999 and another after their teaching practice period, around April to May of 2001. The same questionnaire was used twice in order to enable the researcher to assess whether any change of attitude exists by comparing their answers to both questionnaires. There were four classes of student teachers investigated. The researcher conducted all administration procedures himself. Before distributing the questionnaire, the researcher gave student teachers a simple and direct introduction to the questionnaire. The subjects were told that the data collected in the questionnaire would be used in a research study. Their responses would be kept confidentially and would not be disclosed to any other person or used in other research. Also, it was emphasized that the subjects did not need to write down their names and student numbers, thus their identities could not be discovered. They were asked to provide a self-created 4-digit personal code in both questionnaires in order to match them for comparison. Student teachers were also allowed to complete the questionnaire at home and drop it into the researcher's own pigeon box. Hopefully, all these procedures could provide an ideal situation or atmosphere for voicing opinions about attitudes toward mathematics teaching. Finally, the first round questionnaires were collected, organized and analyzed at the end of January 2001 and the second round questionnaires were collected, organized and analyzed in May 2001.

Teaching Practice (TP) Supervision and Post TP Discussion

As described earlier, this study has two phases. The first phase aims at getting a general picture of the student teachers' academic achievement in mathematics and their affective characteristics about mathematics teaching by using the attitude questionnaire. The second phase aims at clarifying student teachers' pedagogical content knowledge level and getting information on student teachers' math teaching performance. Those data are collected via teaching practice observation and post TP discussion.

Administration of The Case Study

In phase two, teaching practice supervision, thirty-two student teachers were invited to be supervised by the researcher across two academic years, 1999-2001. The researcher had observed their teaching twice during teaching practicum and met them twice in the post TP discussion. Among thirty-two student teachers, some were classified as high achievers in math and the others were classified as low achievers by their academic achievements in math in public examination or equivalent.

I. Post-TP Discussion

After the lesson supervision, the supervisor should share the collected data with the student. He should analyze the data, diagnose mistakes and make plans for the next observation. The student should be encouraged to share the opinions and feelings aroused by the supervisor's comment. The supervisor may give the student opportunity to practice specific behavior in the next observation. Thus the aim of the post TP discussion is to improve the student teacher's PCK in math teaching, to overcome his or her mistakes, to improve his / her attitudes toward math teaching.

II. Observation During Teaching Practice

The supervisor (the researcher) observed the student teachers using a technique based on Acheson & Gall's (1980) model. The stages for this observation resembled Acheson & Gall's clinical supervision cycle, i.e.: Pre-conference, Observation and Post-conference.

The term observation in this study refers to any objective procedure for recording the behaviour, lesson planning and teaching performance of the subjects. Relevant data were collected by two instruments:

1. teaching practice appraisal forms for direct observation and

2. lesson plans.

The Teaching Practice Appraisal Form

The teaching practice appraisal form for mathematics student teachers (see appendix B) was designed by the Hong Kong Institute of Education. It is used for a full view of the student teacher's teaching performance. In the Report Form the student teachers' personalities, knowledge of subject matter, teaching strategies, use of teaching aids and materials, use of language, class management, learning activities, pupil participation, preparation before lesson and follow-up after lesson would be commented on.

Lesson Plan

As a measure of those lessons which were not directly observed during teaching practicum, student teachers were requested to submit a series of lesson plans. (Examples see Appendix C).

In each lesson plan, the details of the following aspects were requested.

Date;

Class (including pupils' characteristics);

Students' Previous Knowledge;

Teaching Objectives;

Teaching Aids;

Teaching Strategy;

Conclusion.

During supervision, the researcher observed and assessed the student teacher's teaching performance and his / her PCK, besides using the teaching practice appraisal form to ascertain the student teachers' confidence in teaching mathematics, in concept presentation and their questioning technique.

3.5 Methods of Analyzing Data

The methods of analyzing data are described in this section. To analyze the quantitative data, the statistical software SPSS and Microsoft Excel 2000 were used on a personal computer. Microsoft Excel 2000 was used to store all the data from the various sources of information, namely the student teachers' public examination result in math (SCK), grades on their teaching practice (math teaching competency), grades on their PCK in math and their attitude survey. The statistical tools in Excel were used to calculate the number of subjects (@count), the means (@AVG), and standard deviation (@STD). The Pearson Product-moment Correlation, t-tests, Cross-tabulation Correlation of Ordinal Variables and ANOVA were carried out using SPSS.

There were two background information variables collected in part 1 of the questionnaire. The first variable is the student teachers' achievement in mathematics.

1. Whether or not the student teachers have studied mathematics at tertiary level prior to enrolling in the teacher-training program, and
2. What is the level of their highest mathematics study while at secondary school?

Another background variable, age, is used to classify students' age categories, either 'mature age' or not. The level of their highest mathematics study is used to define their achievements in mathematics, their levels of subject content knowledge (SCK). Those student teachers who had studied mathematics at tertiary level or had passed either A-level or AS-level mathematics were classified as students with high achievement in mathematics, with sound subject content knowledge (SCK). While those student teachers who only had school certificate mathematics passed were classified as students with low achievement in math, fair in SCK. For overseas students, if they had any recognized equivalent math qualification, this was considered to be valid and classified by the same standard.

Data collected from the teaching practice appraisal form was used to assess students' PCK levels and their overall teaching performance during teaching practice. For each assessing item, such as Attitude in Teaching, Lesson Planning, Selection and Use of Resources etc (in total there are 18 items.), three assessment grades would be offered. They were: distinction, pass and fail. Those grades would be converted into scores 3, 2 and 1 respectively. Normally, only one overall rating of teaching practice performance would be offered to student teachers, graded as distinction, pass or fail. Those grades would be converted into scores, 3, 2 and 1 respectively. For this research, TP achievements were categorized into 5 bands instead of the original 3 grades. This is because in the past few years of TP supervisions, more than 90% student teachers obtained the pass grade, only very few students were assessed to be failing or getting a distinction in their TP. Thus, if we use the 3-point scale to assess their overall TP performance, it would limit the ability to discriminate or rank their math teaching achievements. During lecturer-students field experience consultation meeting, both student and lecturer proposed to change the TP achievement result from 3 grades to 5 bands. After in-depth discussion, the field experience committee accepted this proposal and the 5-point TP scale proposal was submitted to the programme committee for endorsement.

After data collection, various analyses are employed in this study. They are:

- Pearson Product-moment Correlation Coefficients
- t-test
- Cross-tabulation Correlation of Ordinal Variables
- ANOVA

Firstly, as those data collected by questionnaires are assumed to be continuous, Pearson Product-moment Correlation Coefficients can be calculated for the purpose of determining whether correlations exist between achievements in math (including SCK, PCK and teaching practice performance) and each sub-scale in the questionnaire of attitudes. The four factor-based sub-scales are: Anxiety, Confidence & Enjoyment, and Desire for Recognition and Pressure to Conform. The correlation between achievements in math and the overall attitude toward teaching math is also calculated by using Pearson Product-moment Correlation Coefficients. Secondly, inter-correlations will be computed among the attitudes measured for male and female student teachers in courses, CE course and BEd programme. Thirdly, t-test is employed to investigate whether there are any differences in math achievement between the sexes in both courses and in attitudes between the sexes in both courses. Lastly, ANOVA will be employed to test whether significant differences exist among the means of each affective factor, achievement in SCK and PCK. The results of their TP performance will be later used to assess correlations with their math teaching attitude measures.

Chapter Four: Results and Statistical Analysis

4.1 Introduction

The methods of analyzing data have already been described in Chapter Three: Methods. In this chapter the results and statistical analysis of this study are presented. These results aim at determining the answers to the research questions posed in Chapter Two. The primary research question is: What are the effects of Subject Content Knowledge (SCK), Pedagogical Content Knowledge (PCK) and Attitudes Toward Teaching Mathematics on student teachers' teaching competency in mathematics teaching?

The related research questions are:

1. Does mathematics teachers' subject content knowledge interrelate with their pedagogical content knowledge?
2. Does this relationship vary across age, gender and programmes?
3. Are attitudes toward mathematics teaching interrelated with subject content knowledge and pedagogical content knowledge?
4. Do the relationships between attitude toward mathematics teaching and mathematics achievement vary across gender and programmes?

5. Does teaching performance correlate with attitude toward teaching, Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK)?
6. Do changes exist in student teacher's attitude between pre-TP and post-TP?

4.2 Results

4.2.1 Results Regarding Achievements in Math

The achievement of the student teachers in this study can be viewed in two streams. One type of achievement is accomplishment in their past math public exams. This past math achievement background yields student teacher's math subject content knowledge (SCK) levels. From the analysis of their background subject knowledge, we can discover that the percentage distribution of math high achievers (MHA) in 2-Yr Full-time CE Course is severely small as compared with math low achievers (MLA), no matter whether they are math elective students or not. There are only around 10% students in 2-Yr Full-time CE Course categorized as MHA. But it is extremely different in the 4-Yr Full-time BEd Programme, especially for math elective students. All students (100%) passed either A-level or AS-level math, and all are categorized as MHA. This is because at least an AS-level pass in math is required for admission to be a math major student in the BEd programme. The details of these distributions are displayed in Table 4.1 and

Table 4.2.

Table 4.1 Achievement (SCK) in Math Distributions in Stage 1

Courses	**4-Yr Full-time BEd**				**2-Yr Full-time CE**			
	Male		**Female**		**Male**		**Female**	
Elective	Math	Non-math	Math	Non-math	Math	Non-math	Math	Non-math
Achievement (SCK)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)
Year 1	5 (0)	2(3)	8 (0)	2 (6)	1 (4)	0 (5)	1 (7)	0 (8)
Year 2	n.a.	n.a.	n.a.	n.a.	1 (4)	0 (5)	2 (6)	0 (8)
Year 3	5 (0)	1 (4)	8 (0)	1 (7)	n.a.	n.a.	n.a.	n.a.
Total	10 (0)	3 (7)	16 (0)	3 (13)	2 (8)	0 (10)	3 (13)	0 (16)

Table 4.2 Achievement (SCK) in Math Percentage Distributions in Stage 1

	4-Yr Full-time BEd				**2-Yr Full-time CE**			
	Male		**Female**		**Male**		**Female**	
Elective	Math	Non-math	Math	Non-math	Math	Non-math	Math	Non-math
Achievement (SCK)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)
Percentage	100% (0%)	30% (70%)	100% (0%)	19% (81%)	20% (80%)	0% (100%)	19% (81%)	0% (100%)

The subjects of the case studies are 32 student teachers only. They are evenly scattered between programmes and gender. Details of sample distribution appear in Table 3.2 (Chapter 3: sample section).

Table 3.2 Case Studies Distributions in stage 2

Courses	4-Yr Full-time BEd		2-Yr Full-time CE	
	Male	Female	Male	Female
Year 1	4	4	4	4
Year 2	n.a.	n.a.	4	4
Year 3	4	4	n.a.	n.a.
Total	8	8	8	8

Similar distributions are found in stage 2: all math elective students were categorized as MHA, not more than 50% non-math BEd students were categorized as MHA. A much worse situation appeared in the CE programme. Only half math elective students (50%) had an AL or AS level math pass and are classified as MHA. For non-math elective students, no students could be classified as MHA, since in the sample pool, there are no non-math CE students with AL or AS level pass. The detailed SCK distributions in stage 2 are displayed in Table 4.3 and Table 4.4.

Table 4.3 Achievement (SCK) in Math Distributions in Stage2

Courses	4-Yr Full-time BEd				2-Yr Full-time CE			
	Male		Female		Male		Female	
Elective	Math	Non-math	Math	Non-math	Math	Non-math	Math	Non-math
Achievement (SCK)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)
Year 1	2 (0)	0(2)	2 (0)	0(2)	1(1)	0 (2)	1 (1)	0 (2)
Year 2	n.a.	n.a.	n.a.	n.a.	1 (1)	0 (2)	2 (1)	0 (2)
Year 3	2 (0)	1(1)	2 (0)	0(2)	n.a.	n.a.	n.a.	n.a.
Total	4 (0)	1(3)	4 (0)	0(4)	2 (2)	0 (4)	2 (2)	0 (4)

Table 4.4 Achievement (SCK) in Math Percentage Distributions in Stage 2

Courses	4-Yr Full-time BEd				2-Yr Full-time CE			
	Male		Female		Male		Female	
Elective	Math	Non-math	Math	Non-math	Math	Non -math	Math	Non-math
Achievement in Math (SCK)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)	MHA (MLA)
Percentage	100% (0%)	25% (75%)	100% (0%)	0% (100%)	50% (50%)	0% (100%)	50% (50%)	0% (100%)

The other type of achievement in math is defined as Pedagogical Content Knowledge (PCK), which is described as " **knowing the ways of representing and formulating the subject matter that make it comprehensible to students as well as understanding what makes the learning of specific topics easy or difficult" (Even, 1993, P. 94).** This measure focuses on a student teacher's lesson planning and presentation of his or her teaching. In this study, this type of achievement (PCK) was mainly measured by summing a subject's scores achieved in the specified items in their teaching practice appraisal form. Details of items related to PCK in the teaching practice appraisal form are listed in Table 4.5.

Table 4.5 Items for measuring sample's PCK

Planning and Evaluation	Management and Instruction	Communication
• Lesson Planning	• Selection and Use of Resources	• Verbal Communication
• Teaching and Learning Strategies	• Sequencing of learning Activities	• Non-verbal Communication
	• Design of Learning Environment	• Use of Media

Each item's result was graded as distinction, pass or fail. These grades were then translated into 3, 2 and 1 respectively and the total scores were classified into five bands by using the following grade descriptors (neutral score is 16, min. score is 8 and max. score is 24):

A(5): greater than 20 **B(4)**: 18-20 **C(3)**: 15-17 **D(2)**: 12-14

E(1): less than 12

These numeric results were then used for the statistical analysis with student teacher's SCK, TP performance and Attitude in Teaching Math.

The Mean Scores for The Pedagogical Content Knowledge (PCK)

The mean scores for the Pedagogical Content Knowledge (PCK) categorized by year of study and programmes are shown in Table 4.6.

Table 4.6 Pedagogical Content Knowledge (PCK) Mean Distribution

Programmes	**Year of Study**	**Pedagogical Content Knowledge (PCK) Mean**
4-Yr Full-time BEd	Year 1	2.75
	Year 3	3.25
2-Yr Full-time CE	Year 1	2.88
	Year 2 (Final Year)	3.75

At a first glance, it is surprising and positive that student teachers achieve better in PCK as they are promoted year by year. As can be seen in the table, the mean scores for the Pedagogical Content Knowledge (PCK) increased from the first year to third year and from the first year to the final year for the BEd and CE student teachers respectively. Student teachers in the higher year seemed to have much better results in PCK than those in lower years (mean scores of 3.25 versus 2.75 for BEd Year 3 and Year 1 students; mean scores of 3.75 versus 2.88 for Year 2 and Year 1 CE students). It indicates that student teachers' PCK is improved year by year.

4.2.2 Relationship Between SCK and PCK

To explain the relationship between subject content knowledge (SCK) and pedagogical content knowledge (PCK), the Pearson Correlation Coefficient was used to find out whether significant correlations existed between SCK and PCK. Table 4.7 contains the Pearson Correlation Coefficients for each sample of student teachers between subject content knowledge (SCK) and pedagogical content knowledge (PCK) related to their course taken. (For detailed SPSS outputs see Appendix D.)

Table 4.7 Correlations between Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK)

	Courses	**Pedagogical Content Knowledge (PCK)**	**Significance (2-tailed)**
Subject Content Knowledge (SCK)	4-Yr Full-time BEd	0.083	0.759
	2-Yr Full-time CE	-0.054	0.843
	4-Yr Full-time BEd and 2-Yr Full-time CE	0.023	0.900

As shown in the table, no positive associations existed in the 4-Yr Full-time BEd programme (r = 0.083), and also no relationship is found in the 2-Yr Full-time CE course (r = -0.054). Even when the correlation between Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK) was calculated without the effect of the course taken, the relationship was still less strong, and could be considered as nearly independent (r = 0.023). If we plot SCK and PCK on the graph, the points are randomly scattered. Thus the relationship between achievement SCK and achievement PCK in mathematics was considerably less strong, virtually non-existent.

In addition, in order to assess the effect of the training programme offered by HKIEd on student teachers' PCK achievement, a t-test was used to compare the PCK achieved by different years' student teachers in each course. The t-test compared the mean of the first year students to the mean of the third year students in BEd programme. Similarly, the t-test compared the mean of the first year student to the mean of the final year students in CE course. The purpose was to test whether improvement existed in students' PCK levels between the beginning of their exposure to mathematics teaching in their programme and the middle of their second or third year. The details of the t-tests are displayed in Table 4.8. (For detailed SPSS outputs see Appendix E.)

Table 4.8 t-test ratings examining the effectiveness of training programme on PCK achievement

Courses	Pedagogical Content Knowledge (PCK) Mean	t-test Value	Significance (2-tailed)
4-Yr Full-time BEd	Year 1 with Year 3	-0.632	0.537
2-Yr Full-time CE	Year 1 with Year 2 (Final Year)	-1.528	0.149

As stated in the previous section, student teachers in the higher years seemed to have much better results in PCK than those in lower years (mean scores of 3.25 versus 2.75 for BEd Year 3 and Year 1 students; mean scores of 3.75 versus 2.88 for Year 2 and Year 1 CE students). However, for both BEd (Yr 1 & Yr 3) and CE (Yr 1 and Yr 2) student teachers, the result of t-tests showed no statistically significant findings. Thus we cannot confidently conclude that the teacher training programmes offered by the HKIED make a measurable, obvious and notable improvement in student teachers' PCK levels.

The Mean Scores for Teaching Practice (TP) Performance

Since the Teaching Practice (TP) performance was assessed via teaching practice observation, as described in Chapter Three, the sample size in this stage could only be 32. Thus in this analysis, their means were categorized by programmes only.

Both programmes had the same mean in teaching practice supervisions (mean score was 3.00 with S.D. equals 0.97 and mean score was 3.00 with S.D. equals 1.10 for CE and BEd students respectively). Therefore no differences in TP results are found between CE and BEd students.

4.2.2 Gender and Achievement Results

The student teachers' scores in SCK and PCK in math were further examined to determine whether gender differences exist in BEd and CE courses. The results of t-tests are shown in Tables 4.9 and Table4.10. (SPSS outputs are displayed at Appendix F)

Table 4.9 t-test results examining the gender difference on PCK achievement

Courses	Pedagogical Content Knowledge (PCK) Mean	Mean Male (Female)	t-test Value	Significance (2-tailed)
4-Yr Full-time BEd	Males with Females	1.57 (4.11)	-5.791	0.000*
2-Yr Full-time CE	Males with Females	3.13 (3.50)	-0.614	0.549

As can be seen in Table 4.9, there was only a small difference between the mean scores of 2-Year CE males and females (mean scores were 3.13 and 3.50 for males and females respectively, and t = -0.614). On the other hand, it is surprising that the females in BEd course performed much better than males on PCK achievement, the mean scores for males and females being 1.57 and 4.11 respectively, and t-value equals -5.791. There is no doubt that a strong significant difference existed between males and females on the BEd course in their PCK achievement. This phenomenon could be explained by a general tendency on the part of female student teachers, who paid more efforts to preparing their lessons and creating more appropriate teaching aids. Besides, female teachers are perhaps more willing than male teachers to change their presentation and speaking style to be closer to children's ways of speaking and build up closer relationships with their pupils.

Table 4.10 t-test results examining the gender difference on SCK achievement

Courses	Subject Content Knowledge (SCK) Mean	t-test Value	Significance (2-tailed)
4-Yr Full-time BEd	Males with Females	0.475	0.642
2-Yr Full-time CE	Males with Females	0.966	0.350

Table 4.10 presents the details of the results comparing males and females on their subject math content knowledge (SCK), none of which was statistically significant at the 0.05 level. In other words, there was no gender difference found in student teachers' mathematics academic achievement.

4.3 Results Regarding Attitudes Toward Mathematics Teaching

General attitudes toward mathematics teaching were measured by the responses of 102 student teachers to 22 statements, in which they expressed their opinions about mathematics teaching, and in particular concerning the following four attitude sub-scales toward mathematics teaching: Anxiety, Confidence & Enjoyment, Desire for Recognition and Pressure to Conform (see Appendix A). The statements in each sub-scale, the possible score ranges and the actual score ranges obtained by BEd and CE student teachers are shown in Table 4.11.

Table 4.11 The actual ranges of BED and CE Student-teachers on the responses of attitude sub-scales

Sub-scales of attitudes toward mathematics	Statements Involved	Total Number of Statements	Possible Ranges (Min.– Max.)	Actual Ranges (Min. – Max.)		
				BEd and CE Student Teachers	BEd Student Teachers	CE Student Teachers
General Teaching Attitude	All statements	22	22 - 110	56 - 83	59 – 83	56 – 80
Anxiety	1,2,4,6,9,12,17 and 20	8	8 - 40	14 -32	16 – 32	14 – 31
Confidence & Enjoyment	8, 11, 14,16, 18, 19, 21 and 22	8	8- 40	14 - 34	16-32	14 – 34
Desire for Recognition	3, 5 and 7	3	3 - 15	7 - 15	7-15	7 – 15
Pressure to Conform	10, 13 and 15	3	3 - 15	5 - 12	5-11	5 - 12

For example, the anxiety sub-scale comprised 8 statements, which expressed respondents' opinions on their worries about teaching mathematics, with a possible range of 8 to 40. The actual measured ranges were from 14 to 32, 16 to 32 and 14 to 31 for all student teachers, BEd and CE student teachers respectively. Table 4.11 shows no severe differences in ranges of scores on anxiety toward math teaching, confidence & enjoyment, desire of recognition and pressure to conform between BEd and CE student teachers. However, the results of the BEd group do appear slightly more positive than the CE group.

4.3.1 Reliability Estimates

Internal reliability coefficients were calculated for each of the 5 scales, including the overall attitude toward math teaching. Table 4.12 contains alpha reliability coefficients for the three samples (all students, BEd students and CE students) for each of the 5 scales.

Table 4.12 Alpha Reliability Coefficients on student teachers' responses to the attitude scales

Scales (No. of Statements)	BEd and CE		BEd		CE	
	No. of Sample	Alpha	No. of Sample	Alpha	No. of Sample	Alpha
Overall Attitude (22)	6	.6085	47	.6908	49	.4989
Anxiety (8)	103	.7465	51	.7631	52	.6887
Confidence & Enjoyment (8)	101	.7834	50	.7902	51	.7832
Desire for Recognition (3)	104	.5950	52	.6456	52	.5683
Pressure to Conform (3)	100	.4578	50	.5136	50	.4137

As shown in Table 4.12, the coefficient alphas showed adequate reliability for research purposes. Only the coefficient alpha of the sub-scale 'pressure to conform' for all students was 0.4578, a little below the acceptable lower limit 0.5. In summary, all measured alpha values were adequate and comparable to those reported by Biggs (1992) for the Study Process Questionnaire samples in Hong Kong.

4.3.2 Results and Analysis of Measured Attitude Means

Courses and Attitudes

Since both courses of student teachers used the same attitude questionnaire, it was suitable for comparison between courses and between different year groups in particular courses. Means and percentages are shown in Table 4.13.

Table 4.13 Means and Standard Deviations on student teachers' responses to the attitude scales

Scales (No. of Statements)	BEd			CE		
	No. of Sample	Mean (neutral)	S.D.	No. of Sample	Mean (neutral)	S.D.
Overall Attitude (22)	47	69.26 (66)	6.34	49	66.90 (66)	5.88
Anxiety (8)	51	24.94 (24)	4.30	52	22.52 (24)	4.26
Confidence & Enjoyment (8)	50	24.70 (24)	3.83	51	25.04 (24)	4.41
Desire for Recognition (3)	52	11.00 (9)	1.76	52	11.06 (9)	1.99
Pressure to Conform (3)	50	8.42 (9)	1.49	50	8.26 (9)	1.62

Both CE and BEd student teachers were found to have positive attitudes toward teaching mathematics, as their means were greater than the neutral score of 66. BEd student teachers were shown to possess slightly more positive attitudes toward math teaching than the CE student teachers. However, both means are only a little above the neutral score (66), implying that neither group, on average, has a very positive attitude. Analysis of the scale Pressure to Conform reveals that both BEd and CE students felt the pressure to be seen as an outstanding teacher of mathematics. The mean scores on the scale of Pressure to Conform for BEd student teachers and CE student teachers were 8.42 and 8.26 respectively, indicating that both groups had a slightly negative attitude on this scale compared with the neutral score of 9.

The overall interpretation from studying their means was that both BEd and CE samples expressed some confidence and enjoyment but the means of the scale Confidence & Enjoyment were 24.70 and 25.04 for BEd and CE groups respectively, only slightly above the neutral score for this scale of 24. It was quite unexpected that CE students showed more confidence and enjoyment compared with BEd students, as BEd students achieved higher levels in SCK than CE students. The Desire for Recognition mean scores of 11.00 and 11.06 for BEd and

CE students respectively suggested that both groups took pride in being recognized as a good teacher of mathematics. The last scale analyzed in this section was Anxiety toward Math Teaching. The overall interpretation of these means is that there was not a high level of anxiety about math teaching amongst BEd students, but for CE students their scores indicated that they had some negative feelings of anxiety. Over 61% of CE students were anxious about teaching math, while only 39.2% of BEd students showed the same negative feelings. The valid percentages, cumulative percentages of scores and the mode scores of each scale for BEd and CE student teachers are shown in Table 4.14.

Table 4.14 Percentages on student teachers' responses to the attitude scales

Scales (No. of Statements)	Neutral Score	Less than Neutral Score					
		BEd Students			CE Students		
		No. of samples	Cu. %	Mode (no. of students)	No. of samples	Cu. %	Mode (Score)
Overall Attitude (22)	66	16	34%	71 (5)	21`	42.9%	62 (8)
Anxiety (8)	24	24	39.2%	23 & 25 (6)	32	61.5%	20 (8)
Confidence & Enjoyment (8)	24	21	42%	27 (8)	18	35.3%	27 (9)
Desire for Recognition (3)	9	2	3.8%	11 (14)	5	9.6%	12 (15)
Pressure to Conform (3)	9	20	40%	9 (21)	26	52%	8 (14)

As can be seen in Table 4.14, of the other three scales, only in the scale of Confidence & Enjoyment did CE students get a better result than BEd students.

Concerning the other two scales, Desire for Recognition and Pressure to Conform, a completely different picture appeared. More BEd students were found with more positive attitudes toward math teaching than CE students on these two scales. The difference in attitude between BEd and CE students was greatest in response in the Desire for Recognition scale. The percentage of CE students with negative attitudes on this scale was 2.5 times that of the BEd students. For the last scale, Pressure to Conform, CE students also showed worse results compared with BEd students. The percentage of students with negative attitudes on this scale was 52% and 40% for CE and BEd students respectively. (Detailed distributions are shown in Appendix G and some examples in Tables 4.15 and 4.16.)

Table 4.15 Percentage of CE students on Anxiety scale

Scores	Frequency	Percent	Valid Percent	Cumulative Percent
14.00	2	3.8	3.8	3.8
16.00	3	.8	5.8	9.6
17.00	1	1.9	1.9	11.5
18.00	2	3.8	3.8	15.4
19.00	3	5.8	5.8	21.2
20.00	8	15.4	15.4	36.5
21.00	2	3.8	3.8	40.4
22.00	6	11.5	11.5	51.9
23.00	5	9.6	9.6	61.5
24.00	**4**	**7.7**	**7.7**	**69.2**
25.00	5	9.6	9.6	78.8
26.00	1	1.9	1.9	80.8
27.00	3	5.8	5.8	86.5
28.00	2	3.8	3.8	90.4
29.00	1	1.9	1.9	92.3
30.00	1	1.9	1.9	94.2
31.00	3	5.8	5.8	100.0
Total	52	100.0	100.0	

Table 4.16 Percentage of BEd students on Anxiety scale

Scores	Frequency	Percent	Valid Percent	Cumulative Percent
16.00	2	3.8	3.9	3.9
18.00	2	3.8	3.9	7.8
19.00	2	3.8	3.9	11.8
20.00	4	7.7	7.8	19.6
21.00	1	1.9	2.0	21.6
22.00	3	5.8	5.9	27.5
23.00	6	11.5	11.8	39.2
24.00	**3**	**5.8**	**5.9**	**45.1**
25.00	6	11.5	11.8	56.9
26.00	1	1.9	2.0	58.8
27.00	4	7.7	7.8	66.7
28.00	5	9.6	9.8	76.5
29.00	2	3.8	3.9	80.4
30.00	4	7.7	7.8	88.2
31.00	5	9.6	9.8	98.0
32.00	1	1.9	2.0	100.0
Total	51	98.1	100.0	
Missing System	1	1.9		
Total	52	100.0		

4.3.3 T-Test on Various Attitudes Between CE and BEd Student Teachers

A series of t-tests values were calculated to evaluate the differences in the various attitudes between CE and BEd student teachers. The results are displayed in Table 4.17 below and the SPSS outputs are in Appendix H. The analysis reveals only one significant difference. Math teaching Anxiety was significant at the 0.05 Level, confirming that students in the BEd programme were less anxious about teaching mathematics than CE students

Table 4.17 Results of t-test on CE and BEd student teachers responses to the questionnaire of attitudes toward mathematics teaching.

Measures of attitudes toward mathematics	Groups	Results of t-test			
		Mean	S.D.	t-value	Significance p
Total Math Teaching Attitude	CE	66.90	5.88	1.890	0.062
	BEd	69.26	6.34		
Anxiety	CE	22.52	4.26	2.872	0.005*
	BEd	24.94	4.30		
Confidence & Enjoyment	CE	25.04	4.41	-0.412	0.681
	BEd	24.70	3.84		
Desire for Recognition	CE	11.06	1.99	-0.156	0.876
	BEd	11.00	1.76		
Pressure to Conform	CE	8.26	1.62	0.505	0.615
	BEd	8.42	1.49		

- meets criteria for significance at 0.05 level

4.4 Results and Analysis of Measured Means Between Different Year-Groups in BEd and CE Programmes

4.4.1 Year-Groups and Attitudes

A series of t-tests were also performed comparing different year-group students in each course to examine the differences on the various attitude scales. The purpose was to test for an improvement in the students' attitudes after a period of studying mathematical subject content and mathematical method content. Thus the scores of the first-year BEd group were compared with the third-year BEd group and the scores of the first-year CE group were compared with the final-year CE group. The results of the analysis are displayed in Table 4.18 and Table 4.19 below and the SPSS outputs are in Appendix I and J.

Table 4.18 Results of t-tests on the first year and the third year BEd student teachers' responses to the questionnaire of attitudes toward mathematics teaching

Measures of attitudes toward mathematics	Groups	Results of t-test			
		Mean	S.D.	t-value	Significance *p*
Total Math Teaching Attitude	First year	67.80	6.47	*-1.711*	0.094
	Third Year	70.91	5.91		
Anxiety	First year	23.42	4.01	-2.732	0.009*
	Third Year	26.52	4.08		
Confidence & Enjoyment	First year	25.00	4.43	0.549	0.585
	Third Year	24.40	3.19		
Desire for Recognition	First year	10.85	1.80	-0.627	0.534
	Third Year	11.15	1.74		
Pressure to Conform	First year	8.50	1.56	0.393	0.696
	Third Year	8.33	1.43		

*meets criteria for significance at 0.05 level

As seen in Table 4.18 above, for BEd students the differences in attitude between the first year group and the third year group were not significant in four scales out of five, including the overall teaching attitude. However, the relatively high significance in difference in year-groups was found in the scale of Anxiety (t = 2,732, $p<0.05$). This implies that at the very beginning of the course, the first year students had more negative feelings of anxiety about teaching math but a better result was found in the third year group. Although the associated t-values with other scales are not significant at the 0.05 level, the third year group obtained higher means than the first year group in these other scales as shown in Table 4.18.

A similar analysis of the CE-students' attitude scores, comparing the mean scores of the first-year group to the final-year group is displayed in Table 4.19 below (The SPSS outputs are in Appendix J).

Table 4.19 Results of t-tests on the first year and the final year CE student teachers' responses to the questionnaire of attitudes toward mathematics teaching

Measures of attitudes toward mathematics	Groups	Results of t-test			
		Mean	S.D.	t-value	Significance p
Total Math Teaching Attitude	First year	66.67	6.07	-0.302	0.764
	Final Year	67.18	5.76		
Anxiety	First year	20.85	3.30	-6.109	0.000
	Final Year	26.40	3.24		
Confidence & Enjoyment	First year	25.19	4.44	0.248	0.805
	Final Year	24.88	4.47		
Desire for Recognition	First year	9.33	2.18	-5.027	0.000
	Final Year	11.04	2.21		
Pressure to Conform	First year	7.96	1.51	-1.370	0.177
	Final Year	8.61	1.83		

The analysis reveals two significant findings at the 0.05 levels, in the scales of Anxiety and Desire for Recognition (t = -6.109 and –5.027 respectively). The first year students had more anxiety in math teaching than the final year students and more concern about being recognized as an outstanding Math teacher. But in the observation of teaching practice, the researcher also found that Year 2 student teachers dressed much better than their junior classmates and also according to the comment of full time school-teachers, they also had the feeling that Year 2 and Year 3 students were more polite than Year 1 students. This may imply that Year 1 students don't regard their appearance and relationships among colleagues as such important factors, which can affect their performance and their chances of being recognized as an outstanding teacher. Although no more statistically significant differences were found at the 0.05 levels, the final year group did perform better than the first year group on other scales as shown in Table 4.19.

4.5 Gender and Attitudes

To examine gender difference in students' attitudes toward math teaching, an ANOVA analysis was performed on the data, comparing the scores on attitude towards math teaching by gender within different programmes and studying groups. The results of BEd student teachers are shown in Table 4.20 (the detailed SPSS outputs are in Appendix K).

Table 4.20 ANOVA analysis of differences in attitudes toward mathematics teaching – all BEd students by gender.

Measures of attitudes toward mathematics	Studying-groups	Gender	Mean	S.D.	F-value Male vs Female	Significance
Total Math Teaching Attitude	All BEd	Male	69.50	7.05	0.051	0.823
		Female	69.07	5.90		
	1st Year BEd	Male	67.70	6.38	0.004	0.951
		Female	67.84	6.75		
	Third Year BEd	Male	71.30	7.54	0.077	0.785
		Female	70.58	4.46		
Anxiety	All BEd	Male	24.50	4.75	0.342	0.562
		Female	25.23	4.04		
	1st Year BEd	Male	22.92	4.41	0.268	0.609
		Female	23.75	3.86		
	Third Year BEd	Male	26.10	4.75	0.170	0.684
		Female	26.80	3.73		
Confidence & Enjoyment	All BEd	Male	25.30	3.33	0.813	0.372
		Female	24.30	4.15		
	1st Year BEd	Male	25.30	3.50	0.073	0.789
		Female	24.80	5.07		
	Third Year BEd	Male	25.30	3.33	1.347	0.258
		Female	23.80	3.05		
Desire for Recognition	All BEd	Male	11.25	1.97	0.651	0.424
		Female	10.84	1.63		
	1st Year BEd	Male	10.80	2.20	0.010	0.920
		Female	10.87	1.59		
	Third Year BEd	Male	11.70	1.70	1.649	0.211
		Female	10.81	1.72		
Pressure to Conform	All BEd	Male	8.45	1.70	0.013	0.909
		Female	8.40	1.35		
	1st Year BEd	Male	8.70	1.89	0.261	0.614
		Female	8.38	1.36		
	Third Year BEd	Male	8.20	1.55	0.143	0.709
		Female	8.43	1.40		

For all BEd student teachers, the differences in attitudes toward math teaching between males and females were not significant on all five scales. However, when the mean scores recorded in Table 4.20 are further examined to determine whether slight gender differences exist, relatively high differences in gender are found in the scales of "confidence and enjoyment" and "Desire for Recognition" among the third year student teachers. To further describe the gender difference in the scales of "confidence and enjoyment" and "Desire for Recognition" among the third year student teachers, students' response patterns on these two scales are shown in Table 4.21 and Table 4.22 (related SPSS outputs are displayed in Appendix L and M).

Table 4.21 Response patterns of the 3rd Year BEd student teachers of 8 statements in the scale of Confidence & Enjoyment

Statements of attitudes toward teaching mathematics	Gender	Disagree strongly %	Disagree %	Undecided %	Agree %	Agree strongly %
8. I am confident about the methods of teaching mathematics.	Male	0	20	80	0	0
	Female	0	37.5	37.5	25	0
11. I have a lot of self-confidence when it comes to teaching mathematics.	Male	0	20	50	30	0
	Female	0	37.5	50	12.5	0
14. I feel at ease when I'm teaching mathematics at practice teaching.	Male	0	50	0	50	0
	Female	0	6.7	73.3	20	0
16. I enjoy the challenge of teaching a new and difficult concept in mathematics.	Male	0	20	70	10	0
	Female	0	31.3	43.8	25	0
18.Time passes quickly when I'm teaching mathematics at practice teaching.	Male	0		70	30	0
	Female	0	6.3	68.8	18.8	6.3
19. Teaching mathematics at practice is enjoyable and stimulating to me.	Male	0	0	0	100	0
	Female	0	6.3	62.5	31.3	0
21.Teaching Mathematics doesn't scare me at all.	Male	0	40	30	20	10
	Female	0	6.3	18.8	62.5	12.5
22. I like teaching mathematics at practice teaching.	Male	0	0	90	0	10
	Female	0	12.5	68.8	18.8	0

As seen in Table 4.21, the third-year BEd male student teachers enjoyed math teaching more than female student teachers. For example, all male student teachers (100%) agreed with statement 19 "**Teaching mathematics at practice is enjoyable and stimulating to me.**" Among females, only 31.3% expressed the same feeling and, unfortunately, 6.3% of female students reported teaching math as an unenjoyable experience. For statement 22, "**I like teaching mathematics at practice teaching.**", no males disagreed that they like teaching mathematics at practice teaching. However, over

12% of female student teachers disagreed with this statement. In addition, more female student teachers disagreed with the statement 8, "**I am confident about the methods of teaching mathematics.**" than males - over 37% of females disagreed but only 20% of males. For statement 11, "**I have a lot of self-confidence when it comes to teaching mathematics.**", males were found more positive than females, over 80 % males agreed, compared with 60% of females. In summary, it seems that males showed greater confidence and enjoyment in mathematics teaching than females did. Table 4.22 contains the response patterns of the third-year BEd male- and female-students on the scale of Desire for Recognition.

Table 4.22 Response patterns of the 3rd Year BE d student teachers of 3 statements in the scale of Desire for Recognition

Statements of attitudes toward teaching mathematics	Gender	Disagree strongly %	Disagree %	Undecided %	Agree %	Agree strongly %
3. It would make me happy to be recognized by other teachers as an excellent teacher of mathematics.	Male	0	0	20	70	10
	Female	0	0	31.3	62.5	6.3
5. I'd be proud to be the outstanding teacher of mathematics amongst my peers	Male	0	10	20	50	20
	Female	0	12.5	62.5	12.5	12.5
7. I would like the school pupils to recognise me as a good teacher of mathematics.	Male	0	0	20	80	0
	Female	0	0	31.3	56.3	12.5

Although no statistically significant gender differences were found, it is clear that males had higher scores than females. Male student teachers desired to be recognized as good mathematics teachers comparatively more than female student teachers. As seen in Table 4.22, more male student teachers agreed, **"I'd be proud to be the outstanding teacher of mathematics amongst my peers".** Over 70 % of male student teachers enjoyed being assessed as an outstanding math teacher, compared with, only 25 % of females. For statement 3, **"It would make me happy to be recognized by other teachers as an excellent teacher of mathematics."** no males and females disliked to be recognized by other teachers as an excellent math teachers. However, more male students responded positively than females, 80 % and 68% respectively. Concerning CE student teachers, even group by group, no gender differences were found, males and females having nearly the same response patterns toward math teaching in all four scales (see Appendix N).

4.6 Relationships Among Attitudes, Achievements (PCK and SCK) and TP Performance

The scores calculated for each attitude scale were based on the sample's responses to the 22 statements in the attitudes questionnaire. In previous research, many studies have used only a single attitude score by summing up students' responses to all statements to calculate the correlation coefficient with students' achievement scores. However, this can lead to a problem in the reliability of the coefficient. In recent years, researchers have tried to improve on this by using more specific attitude scale scores. In this section, firstly, Pearson Product-Moment Correlation coefficients were computed to examine the intercorrelations among TP performance, PCK, SCK and general math teaching attitudes.

4.6.1 Intercorrelations Among TP Performance, PCK and SCK

Since the Teaching Practice (TP) performance was assessed in stage 2, the sample size in this stage was only 32. Thus it would not be appropriate to analyze this data by groups and by programmes. Thus the data was analyzed for the sample of all students. The results of the analysis are displayed in Table 4.23.

Table 4.23 Correlation Among TP Performance, PCK, SCK and General Attitude of all student teachers

		TP Result	PCK	SCK	General Attitu
TP Result	**Pearson Correlation**	1.000	.880*	.125	.755*
	Sig. (2- tailed)	.	.000	.495	.000
	N	32	32	32	31
PCK	**Pearson Correlation**	.880*	1.000	.023	.645*
	Sig. (2- tailed)	.000	.	.900	.000
	N	32	32	32	31
SCK	**Pearson Correlation**	.125	.023	1.000	.092
	Sig. (2- tailed)	.495	.900	.	.623
	N	32	32	32	31
General Attitude	**Pearson Correlation**	.755*	.645*	.092	1.000
	Sig. (2- tailed)	.000	.000	.623	.
	N	31	31	31	31

*Correlation is significant at the 0.01 level (2 – tailed).

As seen in Table 4.23, for all student teachers, there were three significant correlations found. Teaching practice performance (TP-Result) was highly correlated with students' general math attitudes (r = 0.755, p < 0.01). This indicates that when a student has a more positive attitude toward mathematics teaching, he or she will achieve a better TP result in math teaching by contrast with the students with worse attitudes toward math teaching. Teaching practice performance is also highly correlated with students' pedagogical content knowledge (PCK) ($r = 0.880, p < 0.01$). As Even (1993) stated, PCK is " **knowing the ways of representing and formulating the subject matter that make it comprehensible to others as well as understanding what makes the learning of specific topics easy or difficult" (P. 94).** Thus it would be expected that when a student teacher has better PCK, his or her teaching performance would be better. In addition, Table 4.23 shows a positive significant correlation between general math attitude and PCK ($r = 0.645, p < 0.01$).

4.6.2 Relationship Between Attitudes and Achievements for All Student Teachers

Correlation analysis was performed to examine the relationship between the attitude sub-scales and achievements for all student teachers (BEd and CE students). The results of the analyses are given in Table 4.24 (the detailed SPSS outputs are in Appendix O).

Table 4.24 Correlation between attitude scales and achievements of all students

Scales of attitudes toward mathematics	**TP Result (Sig. 2-tailed)**	**PCK (Sig. 2-tailed)**	**SCK(Sig. 2-tailed)**
General Teaching Attitude	.755**(.000)	.645** (.000)	.092(.623)
Anxiety	.697** (.000)	.585** (.000)	.251(.166)
Confidence & Enjoyment	.343(.059)	.301(.100)	-.164(.379)
Desire for Recognition	.249(.169)	.285(.114)	-.079(.669)
Pressure to Conform	.602** (.000)	.471** (.007)	.170(.352)

**Correlation is significant at the 0.01 level (2-tailed).

As can be seen in Table 4.21a, the correlation coefficients of Teaching Practice Performance with scales of General Teaching Attitude (22 statements), Anxiety Towards Math Teaching (8 statements) and Pressure to Conform (3 statements) for all student teachers were 0.755, 0.697 and 0.602 respectively; these are statistically significant at the 0.01 level. This indicates that these scales have a significant influence on student teachers' math teaching effectiveness. However, of the other two specific attitude scales, the relationship between Teaching Practice Performance and scales of Confidence & Enjoyment and Desire for Recognition were surprisingly weak ($r = 0.343$ and 0.249 respectively).

Similar results were found for the relationship of Pedagogical Content Knowledge (PCK) with scales of attitudes toward mathematics. The correlation coefficients of Pedagogical Content Knowledge (PCK) with scales of General Teaching Attitude, Anxiety Towards Math Teaching and Pressure to Conform of all student teachers were 0.645, 0.585 and 0.471 respectively (statistically significant at the 0.01 level).

On the other hand, there were no significant relationships found between students' Subject Content Knowledge (SCK) and the scales of attitudes toward mathematics.

4.6.3 Relationship Between Attitudes and Achievements for BEd Student Teachers

Similar correlation analysis was performed for the BEd-students to determine whether a significant relationship exists between students' achievements (TP performance, PCK and SCK) and attitudes toward math teaching of BEd students. Very similar results as the previous sample (all student teachers) were found. The results of the analysis are displayed in Table 4.25 below (the SPSS outputs are recorded in Appendix P).

Table 4.25 Correlations between attitude scales and achievements of BEd students

Measures of Attitudes Toward Mathematics	TP (Sig. 2-tailed)	PCK (Sig. 2-tailed)	SCK(Sig. 2-tailed)
General Teaching Attitude	.792**(.000)	.652**(0.08)	.149(0.596)
Anxiety	.828** (.000)	.678** (0.04)	.301(.258)
Confidence & Enjoyment	.362(.169)	.315(.235)	.177(.512)
Desire for Recognition	.337(.201)	.313(.238)	.000(1.000)
Pressure to Conform	.727** (.001)	.532*(.034)	.239(.372)

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The analysis reveals three significant findings at the 0.01 levels, between Teaching Practice Performance and scales of General Teaching Attitude, Anxiety Towards Math Teaching and Pressure to Conform of BEd student teachers. Similarly, there were also three significant relationships found between students' Pedagogical Content Knowledge (PCK) achievement and scales of General Teaching Attitude, Anxiety Towards Math Teaching and Pressure to Conform of BEd student teachers. There were no significant correlations between students' Subject Content Knowledge (SCK) and the attitude scales.

4.6.4 Relationship Between Attitudes and Achievements for CE Student Teachers

Correlations for the CE-students also showed very similar results. The only distinctive finding was that there was no significant relationship found between the achievements of TP performance and PCK with the specific scale of Pressure to Conform (r equals 0.460 and 0.443 respectively) in the CE group. By contrast, the BEd group had a statistically significant relationship in this respect. The results of the analysis are displayed in Table 4.26 below (the SPSS outputs are in Appendix Q).

Table 4.26 Correlations between achievements and attitudes for CE students

Measures of Attitudes Toward Mathematics	TP (Sig. 2-tailed)	PCK (Sig. 2-tailed)	SCK(Sig. 2-tailed)
General Teaching Attitude	.709**(.002)	.640**(.008)	.034(.902)
Anxiety	.625** (.010)	.614*(.011)	.224(.404)
Confidence & Enjoyment	.333(.208)	.230(.392)	-.262(.327)
Desire for Recognition	.234(.383)	.150(.580)	-.438(.090)
Pressure to Conform	.460(.073)	.443(.086)	.081(.766)

** Correlation is significant at the 0.01 level (2-tailed).

4.7 Intercorrelations Among Attitude Measures

Many studies have suggested that the effect of attitudes on achievements was indirect and the achievement levels interacted with specific scales of attitude in different ways (Aiken, 1980; Watson, 1987; Drew & Watkins 1998). Furthermore, it had been found that different aspects of attitude showed differential influences on students (Szetela, 1973; Reynolds & Walberg, 1992; Relich, 1996). However, the pattern of the relationships among the attitude scales was not obvious. At this stage of study it seemed appropriate to investigate whether intercorrelations among the attitude scales existed. Correlation analysis was carried out on all sample groups (all student teachers, BEd and CE student teachers). As reported in the previous sections, there were no significant differences in various attitudes among different sample groups, thus it was expected there would be similar findings for each group. The results of the analysis are displayed in Table 4.27 – Table 4.29 below (the SPSS outputs are in Appendix R).

Intercorrelations among attitude measures for all student teachers

For all student teachers (see Table 4.27 below), a significant correlation between Anxiety and Pressure to Conform was found ($r = 0.743$ and $p < 0.01$).

Table 4.27 Intercorrelations among the attitude measures for all student teachers

Scales of Attitudes Toward Mathematics	Anxiety	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
Anxiety	---	.066(.725)	.207(.255)	.743**(.000)
Confidence & Enjoyment	.066(.725)	---	.461**(.009)	.202(.275)
Desire for Recognition	.207(.255)	.461**(.009)	----	-.043(.816)
Pressure to Conform	.743**(.000)	.202(.275)	-.043(.816)	---

** Correlation is significant at the 0.01 level (2-tailed).

It is logical that if a student teacher has anxiety toward math teaching, he or she would also feel pressure to be an outstanding teacher of mathematics. Table 4.27 also shows a significant correlation between Confidence & Enjoyment and Desire for Recognition ($r = 0.461$, $p < 0.01$). This suggests that once a student teacher becomes more confident and enjoys teaching mathematics, he or she would also like to be recognized as an excellent teacher of mathematics by other teachers or his or her peers. Table 4.27 shows non-significant correlations between Anxiety and Confidence & Enjoyment, Anxiety and Desire for Recognition with $r = 0.066$, $p > 0.01$ and $r = 0.207, p > 0.01$ respectively.

Intercorrelations Among Attitude Measures for CE Student Teachers

Considering the CE student teachers, as can be seen in Table 4.28 below, similar results to those for all students were found. There was a significant correlation at 0.01 level between Anxiety and Pressure to Conform scores ($r = 0.891, p < 0.01$) and between Confidence & Enjoyment and Desire for Recognition ($r = 0.891, p < 0.01$). There were no further significant correlations found in other combinations.

Table 4.28 Intercorrelations among the attitude measures for CE student teachers

Scales of attitudes toward mathematics	Anxiety	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
Anxiety	---	-.114(.674)	-.041(.880)	.891**(.000)
Confidence & Enjoyment	-.114(.674)	---	.678**(.004)	-.157(.562)
Desire for Recognition	-.041(.880)	.678**(.004)	----	-.043(.874)
Pressure to Conform	.891**(.000)	-.157(.562)	-.043(.874)	---

** Correlation is significant at the 0.01 level (2-tailed).

Intercorrelations Among Attitude Measures for BEd Student Teachers

Again, for BEd students, results were very similar to those reported above, as can be seen in Table 4.29.

Table 4.29 Intercorrelations among the attitude measures for BEd student teachers

Scales of attitudes toward mathemat	Anxiety	Confidence & Enjoyment	Desire for Recognition	Pressure to Confo
Anxiety	---	.428(.098)	.488(.055)	.664**(.005)
Confidence & Enjoyment	.428(.098)	---	.635**(.008)	-.157(.562)
Desire for Recognition	.488(.055)	.635**(.008)	----	-.050(.854)
Pressure to Conform	.664**(.005)	-.157(.562)	-.050(.854)	---

** Correlation is significant at the 0.01 level (2-tailed).

4.8 Differences between Pre-TP and Post-TP attitudes

As stated in Chapter 3, those student teachers involved in stage 2, the TP observations, were asked to complete the attitude question once again, once his or her teaching supervision was completed. This administration yielded post-TP data for the 22 statements and hence for the various scales of attitudes. The purpose of comparing student teachers' pre- and post-TP attitudes was to test whether student teachers had changed their attitudes between the beginning of their courses and at the middle of the second year for 2-Year CE course or at the middle of the third year for 4-Year BEd programme. A series of t-tests were performed comparing the pre- and post-TP attitude by groups (all student teachers, BEd and CE student teachers) to examine the changes in attitudes. The results of these analyses are presented in Tables 4.30 – 4.32 (and the related SPSS output is displayed in Appendix S).

4.8.1 Comparing Pre-TP and Post-TP Attitudes for All Student Teachers

As seen in Table 4.30 below, for all student teachers, the differences in attitude between Pre-TP and Post-TP periods were not statistically significant for two scales out of the five scales. Although the associated t-value for Anxiety was not significant at the 0.05 level, the mean score at post-TP was better than the mean score at pre-TP (mean = 24.22 versus mean = 23.72). It implies that there was a slight improvement in student teachers' attitude toward anxiety of math teaching. When talking with them in post-TP discussion about their unpleasant teaching experience in TP, among the 32 student teachers nearly all indicated that nothing memorably bad had occurred. Only two student teachers indicated that they had problems but not associated with anxiety of math teaching. They only expressed difficulty with teaching senior form mathematical concepts, such as direct and indirect proportion. They complained that they are not taking math as the selected elective but they were assigned to teach senior form math. Nevertheless, they still enjoyed their math teaching, despite having to do more teaching preparation.

Table 4.30 T-test results comparing Pre-TP and Post-TP attitudes for all student teachers

Measures of Attitudes Toward Mathematics	Pre-TP / Post-TP	Results of t-test			
		Mean	S.D.	t-value	Significance p
Total Math Teaching Attitude	Pre-TP Post-TP	68.03 72.36	6.16 10.22	-2.857**	.005
Anxiety	Pre-TP Post-TP	23.72 24.22	4.43 6.19	-.505	.615
Confidence & Enjoyment	Pre-TP Post-TP	24.91 27.81	4.12 3.57	-3.529**	.001
Desire for Recognition	Pre-TP Post-TP	11.03 10.93	1.87 2.42	.225	.823
Pressure to Conform	Pre-TP Post-TP	8.34 9.09	1.58 2.43	-2.043*	.043

**meets criteria for significance at 0.01 level *meets criteria for significance at 0.05 level

In Table 4.30, the difference between the pre-TP and the post-TP is statistically significant in general math attitude at 0.01 level (t = -2.857, $p < 0.01$). The means increased from 68.03to 72.36 from pre-TP to post-TP. In addition, a relatively high significance in difference was found in the scale of Confidence & Enjoyment (t = -3.529, p<0.01). The mean at Pre-TP of the scale Confidence & Enjoyment was 24.91 with a standard deviation of 4.12. By contrast, the mean at post-TP of this scale was 27.81 with a standard deviation of 3.57. This implies an improvement in student teachers' teaching confidence and also that student teachers enjoyed their math teaching more than at the beginning of their courses. The other significant difference was found on the scale of Pressure to Conform (t = -2.043, p<0.05). It appears that at the beginning of their courses, student teachers had negative feelings on this scale, feeling pressure to be an outstanding math teacher and also that such a label would make them feel unpleasantly conspicuous. Eventually, their bad feelings changed a little and their teaching confidence increased.

4.8.2 Comparing Pre-TP and Post-TP Attitudes for BEd Student Teachers

As can be seen in Table 4.31, when BEd students were analyzed, there was only one significant difference found, on the scale of Desire for Recognition (t = 2.112, p <0.05). Unfortunately, the result was negative.

Table 4.31 T-test results comparing Pre-TP and Post-TP attitudes for BEd student teachers

Measures of Attitudes Toward Mathematics	Pre-TP / Post-TP	Results of t-test			
		Mean	S.D.	t-value	Significance *p*
Total Math Teaching Attitude	Pre-TP	69.26	6.34	-1.197	-1.525
	Post-TP	72.00	11.14		
Anxiety	Pre-TP	24.94	4.30	-.516	.608
	Post-TP	25.63	5.58		
Confidence & Enjoyment	Pre-TP	24.70	3.83	-1.953	.055
	Post-TP	26.80	2.93		
Desire for Recognition	Pre-TP	11.00	1.76	2.112*	.039
	Post-TP	9.75	2.89		
Pressure to Conform	Pre-TP	8.42	1.49	-1.525	.132
	Post-TP	9.19	2.43		

*meets criteria for significance at 0.05 level

At the beginning of their courses, student teachers had strong positive feelings on this scale. They were happy to be recognized by other people as a good primary math teacher but, at the end of their TP, their attitude toward this issue was changed. When talking with them in post-TP discussion about whether they felt happy about being recognized as a good math teacher, among 16 BEd student teachers nearly all said that they didn't mind whether they were recognized as a good math teacher. They were only concerned about whether they were being commented on as an irresponsible, unfit math teacher. They didn't mind whether they only got a pass, without merit or distinction in their TP performance, and they worried about only they whether would be able to pass the math TP supervisions. Two BEd students even indicated that as they were good in math, they had already enrolled in a BSc programme and were going to be secondary math teachers. From their attitudes, there is a danger that BEd student teachers are less enthusiastic about teaching math. It is also a concern that if student teachers hold such negative attitudes, they are not likely to recognize the similar errors their students may make. They will pass their own philosophy on their own worth to their pupils.

For other scales, there were no statistically significant findings. Fortunately, although the associated t-values were not significant at the 0.05 level, all mean scores at post-TP were better than the mean scores at pre-TP. This implies at least a slight improvement existed in student teachers' attitudes among these scales.

4.8.3 Comparing Pre-TP and Post-TP Attitudes for CE Student Teachers

For CE student teachers, there was much more improvement in attitudes, comparing their Pre- and Post-TP attitudes scores. The results of this analysis are presented in Table 4.32.

Table 4.32 T-test results comparing Pre-TP and Post-TP attitudes for CE student teachers

Measures of Attitudes Toward Mathematics	Pre-TP / Post-TP	Results of t-test			
		Mean	S.D.	t-value	Significance *p*
Total Math Teaching Attitude	Pre-TP	66.88	5.82	-2.929**	.005
	Post-TP	72.69	9.63		
Anxiety	Pre-TP	22.52	4.26	-.209	.835
	Post-TP	22.81	6.63		
Confidence & Enjoyment	Pre-TP	25.11	4.40	-2.957**	.004
	Post-TP	28.75	3.94		
Desire for Recognition	Pre-TP	11.06	1.99	-2.071*	.042
	Post-TP	12.13	.89		
Pressure to Conform	Pre-TP	8.26	1.68	-1.354	.180
	Post-TP	9.00	2.50		

**meets criteria for significance at 0.01 level

*meets criteria for significance at 0.05 level

The analysis reveals three significant findings: for Total Math Teaching Attitude, Confidence & Enjoyment and Desire for Recognition (t = -2.929, -2.957 and -2.071 respectively), the CE students having more positive attitudes at post-TP than at the beginning of their courses. The CE students showed more concern about being recognized as an outstanding Math teacher after TP than at the beginning of their course. Compared with BEd students, they were more enthusiastic, confident in math teaching after studying nearly one or two years at the HKIEd. But in teaching practice, the researcher still found that they felt pressure about being commented on as an outstanding teacher of mathematics. When talking with them in post-TP discussion about whether they felt happy as being recognized as a good math teacher, more than half the CE student teachers said that they didn't think that they would be assessed or commented on as an excellent math teacher since their status is lower than BEd teachers or teachers with an ordinary degree. Thus some students have planned to have further studies in order to achieve a degree. This could be a matter for concern if they use an academic degree as the only criterion for assessing a teacher's teaching performance.

In summary, this chapter has described the results of various analyses of student teachers' attitudes and achievements. This was organized in two broad categories. The first concerns achievement results, which included teaching practice overall performance, student's subject content knowledge (SCK) in mathematics and their pedagogical content knowledge (PCK) in mathematics. The second concerns student teachers' attitudes toward mathematics teaching. The implications of these results are discussed in more detail in the next chapter.

Chapter 5: Findings, Conclusions and Recommendations of The Study

5.1 Introduction

In Chapter four the results of the study were given regarding the impact of Subject Content Knowledge (SCK), Pedagogical Content Knowledge (PCK) and Attitudes Toward Teaching Mathematics on student teachers' teaching performance in mathematics teaching in their teaching practice. In this chapter, the most significant findings emerging from the investigation will be summarized and conclusions will be drawn from these findings. These conclusions are then used to determine the answers to the research questions, which were posed in the last section of Chapter Two. Finally, recommendations and implications of the study are presented. The primary research question is: What are the effects of Subject Content Knowledge (SCK), Pedagogical Content Knowledge (PCK) and Attitudes Toward Teaching Mathematics on student teachers' teaching competency in mathematics teaching.

The related research questions are

1. Does mathematics teachers' subject content knowledge interrelate with their pedagogical content knowledge?

2. Does this relationship vary across gender and programmes?
3. Are attitudes toward mathematics teaching interrelated with subject content knowledge and pedagogical content knowledge?
4. Do the relationships between attitude toward mathematics teaching and mathematics achievement vary across gender and programmes?
5. Does teaching performance correlate with attitude toward teaching, subject content knowledge and pedagogical content knowledge?
6. Do changes exist in student teacher's attitude between pre-TP and post-TP?

5.2 Findings

Numerous positive and negative findings emerged in the study. For the purposes of drawing conclusions from these findings and of providing answers to the research questions, these findings are summarized as follows.

5.2.1 Summary of Achievement in Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK)

Subject Content Knowledge (SCK)

Similar percentages of Mathematics High Achievers (MHA) are found in both Pre- and Post-TP stages among CE and BEd students. Around 25% of students (4 out of 16) in the 2-Yr Full-time CE Course were categorized as Mathematics High Achievers (MHA). For 4-Yr Full-time BEd students, nearly 57% of students (9 out of 16) are MHA, especially for math elective BEd students, where all students were categorized as MHA. Therefore, in conclusion, BEd students have much better subject knowledge than CE students.

Pedagogical Content Knowledge (PCK)

Surprisingly, by the results of measuring student teachers' lesson planning and presentation of his or her teaching in TP, CE students were found to have better PCK than BEd students. On the whole, student teachers in the higher years of study have much better results in PCK than those in lower years. This suggests that student teachers' PCK is improved year by year.

Relationship Between SCK and PCK

No significant relationships were found between subject content knowledge and pedagogical content knowledge among HKIEd 2-Yr CE and 4-Yr BEd student teachers. Even when the correlation between SCK and PCK was calculated irrespective of the course taken, the relationship was still less weak, and nearly could be considered as independent.

Gender Difference in PCK

Among CE student teachers, although the difference is not statistically significant, females did better than males in achieving PCK scores in their TP teaching. However, for BEd student teachers, a strong significant difference existed between males and females in their PCK achievements. The females on the BEd course performed much better than males on PCK achievement. On the whole, females did better than males on presenting math content in their math teaching.

Gender Difference in SCK Achievement

There was no gender difference in student teachers' mathematics subject content knowledge in all sample groups (all student teachers, BEd and CE student teachers).

5.2.2 Summary of Intercorrelations among TP Performance, PCK, SCK and Attitudes Toward Math Teaching

No statistically significant differences in teaching practice results were found between CE and BEd students. However, there were three statistically significant correlations found. Teaching practice performance was highly correlated with students' general math attitudes. Teaching practice performance was also highly correlated with students' pedagogical content knowledge. Lastly, positive significant correlations existed between general math attitude and pedagogical content knowledge. However, it is more important to note that no significant relationship was found between teaching practice performance and subject content knowledge.

5.2.3 Summary of Attitudes Toward Mathematics Teaching

Attitude Scales

General Attitudes Toward Math Teaching: Both CE and BEd student teachers were found to have positive attitudes toward teaching mathematics. BEd student teachers were shown to possess more positive attitudes toward math teaching than the CE student teachers.

Pressure to Conform: Both BEd and CE students had negative attitudes on this scale, and felt pressure to be an outstanding teacher of mathematics.

Confidence and Enjoyment: both BEd and CE samples expressed some confidence and enjoyment in teaching mathematics but only just above the neutral score. It was quite unexpected that CE students showed more confidence and enjoyment than BEd students.

Desire for Recognition: BEd and CE students had positive attitudes on this scale, showing feelings of pride in being recognized as a good teacher of mathematics.

Anxiety: There was not a high level anxiety toward math teaching amongst BEd students but CE students were worse. On the whole, BEd students were less anxious about teaching mathematics than CE students

Intercorrelations Among Attitude Scales

Similar results were found in the three sample groups (all students, BEd students and CE students). Two significant correlations were found. The first was a high positive relationship between Anxiety and Pressure to Conform and the second between Confidence & Enjoyment and Desire for Recognition.

Year Groups Differences on Various Attitudes Scales

For BEd Students: the differences in attitude between the first year group and the third year group were not significant in three scales out of four. The only significant difference found was on the scale of Anxiety. Year 3 students had less anxiety than Year 1 students.

For CE Students: There were two significant differences found, for the scales of Anxiety and Desire for Recognition. The first year students had more anxiety in math teaching than the final year students. The final year students showed more concern about being recognized as an outstanding Math teacher than the first year students

Gender Differences on Various Attitudes Measures

For BEd Student Teachers: The differences in attitudes toward math teaching between males and females were not significant for all scales.

For CE Student Teachers: As BEd students, no gender differences were found. Males and females had nearly the same response patterns toward math teaching for all attitude scales.

Relationship Between Attitudes and Achievements

For All Student Teachers: Student teachers' math teaching competency in TP was correlated with the general attitude toward math teaching and the specific scales of Anxiety and Pressure to Conform. The analysis also revealed student teachers' Pedagogical Content Knowledge (SCK) was correlated with general attitudes toward math teaching and the scales of Anxiety and Pressure to Conform. On the other hand, there were no significant relationships found between students' Subject Content Knowledge (SCK) and the scales of attitudes toward mathematics.

For BEd Students Teachers: Exactly the same results as the previous sample were found.

For CE Students Teachers: Nearly the same results as the previous two samples were found. The only distinctive finding was that there was no significant relationship between the achievements of TP performance and PCK with the specific scale of Pressure to Conform.

5.2.4 Summary of Differences Between Pre-TP and Post-TP Attitudes

For All Students: The difference between the pre-TP and the post-TP was statistically significant in general math attitude. Another relatively high significance in difference was found in the scale of Confidence & Enjoyment. The last positive significant difference was found in the scale of Pressure to Conform.

For BEd Student Teachers: There was only one negative significant difference found, on the scale of Desire for Recognition.

For CE Student Teachers: There was much more improvement in attitudes between Pre- and Post-TP than for the BEd students. The analysis revealed three significant findings, in the scales of General Math Teaching Attitude, Confidence & Enjoyment and Desire for Recognition. CE students also had more positive attitudes to math teaching at post-TP than at the beginning of their courses.

5.3 Conclusions and Discussion

In terms of one primary research question and six related research questions which guided this study, the findings provide insights to them, provide the sources for discussion and also provide directions for other interested researchers to have further investigation on the issue of math teachers' teaching competency.

5.3.1 The Effects of Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK) on the Teaching Performance

The primary research question is: What are the effects of Subject Content Knowledge (SCK), Pedagogical Content Knowledge (PCK) and Attitudes Toward Teaching Mathematics on student teachers' teaching performance in mathematics? As stated by Noddings (1990) and Confrey (1990) the mathematics teacher's main function is to establish mathematical learning environments that encourage students to explore and raise questions in their studying. They claim that when doing so, teachers' pedagogical content knowledge, which includes questions they ask, activities they design, teaching aids they use and student's suggestions they follow, are based on their subject content knowledge. Thus they feel that an important initial step in improving mathematics teaching should be better subject content knowledge preparation for math teachers. Thus many researchers assumed that subject content knowledge and pedagogical content knowledge should be positively correlated with math teaching performance and pedagogical content knowledge is influenced by subject content knowledge (Ball, 1991; Confrey, 1990; Noddings, 1990 and Shulman, 1986). Although this study found that pedagogical content knowledge (PCK) has strong positive relationship with student's performance in math teaching, no significant effect was found from subject content knowledge (SCK) on teaching practice performance. In addition, it is surprising that PCK is not correlated with SCK. In the study, BEd students were found to have much better SCK than CE students but CE students were found to have better PCK than BEd students and no statistically significant differences in teaching practice performance were found between CE and BEd students. Thus it is unrealistic to expect all good in math subject-matter teachers to be good in math teaching and also have much better PCK.

5.3.2 The Interrelationships Between Attitude towards Math Teaching with Subject Content Knowledge (SCK), Pedagogical Content Knowledge (PCK) and Teaching Performance

For the other research questions: Are attitudes toward mathematics teaching interrelated with Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK)? Does attitude toward teaching correlate with teaching performance? This study found that a general attitude toward math teaching has a strong positive effect on student's performance in math teaching. It also found that general attitude toward math teaching is positively correlated with student's pedagogical content knowledge. Unfortunately, general attitude did not appear to be related to subject content knowledge. Once again, it is unrealistic to expect all math teachers who are good in subject content knowledge to be embedded with positive attitudes toward math teaching. In addition, subject content knowledge also has no significant relationships with any scale of the attitudes toward mathematics teaching. Thus in the study, subject content knowledge is exactly independent with teaching performance, pedagogic content knowledge and attitudes toward mathematics.

Figure 5.1 explains the interrelation among these variables: attitude towards teaching, subject content knowledge (SCK), pedagogical content knowledge (PCK) and the teaching performance with respect to mathematics.

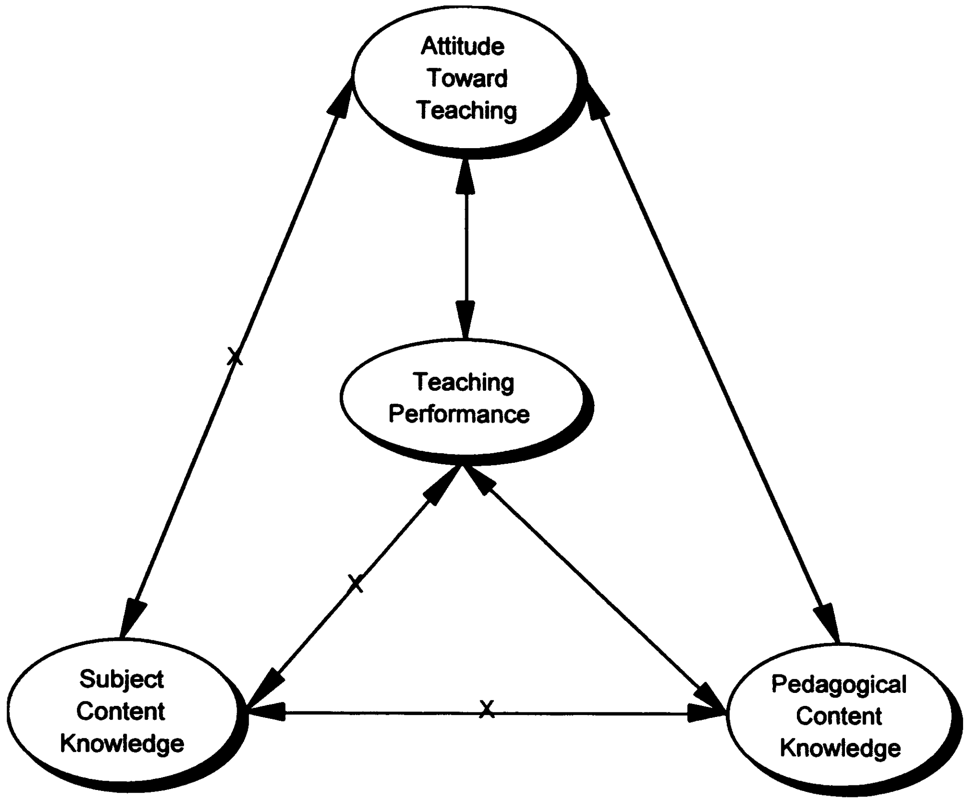

Figure 5.1 Interrelation among attitude, SCK, PCK and the teaching performance

However, it should be noted that these findings only relate to the primary mathematics stream, and even those student teachers who are categorized as mathematics low achievers (MLA), they still have passed ordinary level mathematics. This implies that the minimum requirement of holding an ordinary level mathematics pass for enrolling as a math elective student teacher is still acceptable in Hong Kong. However, for secondary mathematics teaching, as the math knowledge being presented to students is more subject-specific, abstract and harder when compared with the knowledge being taught in primary math lessons, further research is needed to re-test the hypotheses developed here again if the sample is changed from primary student teachers to secondary student teachers. Once again, in Hong Kong primary mathematics teaching, the planning and preparation of lessons is mainly textbook oriented; all mathematics concepts presentation approaches and class practice exercises have already been planned and scheduled by the textbook authors. Primary teachers mainly follow the teaching instructions suggested in the " Teacher Guide" to teach their pupils, self-designed supplementary worksheets or exercises are provided for pupils if necessary. It is extremely different from those countries where they advocate teaching by using self-tailored materials. For example, in Australian primary schools, there is no textbook; teachers prepare all teaching content and practical worksheets themselves. Therefore the requirement of SCK, PCK and attitude in teaching are absolutely different from Hong Kong. For this reason, even within the same stream, primary mathematics, further research is needed to examine teachers' attitudes in mathematics teaching, SCK, PCK and their teaching competency once the research context is changed to be outside Hong Kong.

5.3.3 Gender and Programme Differences in Attitude Toward Teaching, PCK and SCK in Mathematics

In this study, the researcher also was concerned to establish whether gender and programme differences exist in attitude toward teaching, PCK and SCK in mathematics. The study found that, comparing the mean scores on each attitude scale, male student teachers (especially for the third-year BEd) got slightly better results on the scales of "Confidence and Enjoyment" and " Desire for Recognition" but the differences in attitudes toward math teaching between males and females were not statistically significant for all attitude scales. However, regarding PCK, SCK achievements and math teaching performance, among CE student teachers, females did slightly better than males in PCK. Among BEd student teachers, this difference was greater, the females performing much better than males in PCK score. Generally speaking, females did better than males on presenting math content in their TP teaching but there was no statistical gender difference in SCK and TP teaching performance. By assessing their written lesson plans and self-made teaching aids, it is easy to discover that female student teachers had paid more efforts on these preparations. In addition, during teaching practice, the researcher also found that females are more patient to explain math concepts to their pupils than males and they are also more willing than male student teachers to change their presentation and speaking style for the purposes of achieving better teaching effectiveness. From this study, one could see that the gender differences in achieving PCK truly existed. This gender difference in PCK might exert an effect on student teachers' teaching performance and eventually lead to gender difference in teaching competency. **Are females born to be more suitable than males to teach in primary schools?** This question cannot be answered here and it is not an objective in this study but it does need serious consideration and is worth further investigation. The HKIED annual gender survey of first year full-time students (1999-2000) provides interested parties with a better understanding of male and female enrolment in primary and secondary courses. In the survey, the ratio between female and male respondents was 3:1 but for BEd and ECE (Early Childhood Education) courses, this ratio is particularly high, 10.6:1 and 26.0:1 respectively. On the other hand, for secondary courses the ratios are only 2.0:1, 3.5:1 and 2.6:1 for 2SC, 2SE and 3SC respectively. The survey indicates that more females than males prefer to enroll in kindergarten and primary courses. The details of the ratios of female to male respondents by courses are shown in Table 5.1.

Table 5.1 Ratio of Female to Male Registration on the HKIEd Courses

Course	Female : Male
2PC	2.6 : 1
3PC	3.0 : 1
2SC	2.0 : 1
2SE	3.5 : 1
3SC	2.6 : 1
ECE	26.0 : 1
BEd	10.6 : 1

In the present study, when comparisons were made between CE and BEd student teachers, one could see that BEd student teachers had better previous subject content knowledge (SCK) than CE student teachers, but it is surprising that CE student teachers had better PCK than BEd student teachers in their TP. As PCK is found to be statistically correlated with teaching performance, general public hopes that BEd student teachers would perform better than CE student teachers is a logical expectation because BEd students have achieved better SCK in matriculation and also have been studying much longer than CE student teachers in the HKIEd. However, this is not confirmed by the results of this research.

PCK is found to be positively correlated with math teaching performance, there are important implications for how the teacher-training institute and related lecturers design and provide appropriate modules and lectures for their student teachers. The program structure, the balance between subject knowledge modules (academic study modules) and pedagogical content modules (curriculum and teaching modules), should be reviewed. In addition, as general attitude toward math teaching is found to be highly correlated with students' teaching practice performance, courses for BEd and CE students should include more modules designed to increase student teachers' awareness of the importance of attitude towards math teaching and the usage of pedagogical content knowledge in teaching mathematics. Thus some additional aims should be involved in some specific curriculum and teaching modules. They are

- To stimulate the student teacher's interest in acquiring pedagogical content knowledge (PCK);
- To develop the student teacher's ability in the use of teaching aids, language and activity in teaching mathematics concepts and skills.
- To promote the student teacher's powers of observation, diagnosis, analysis and judgment for the purpose to make him / her to have a deep understanding of their pupils' needs.
- To make the student teacher aware of the relationships of teaching performance with some specific attitude scales, such as Anxiety Towards Mathematics Teaching, Pressure to Conform in mathematics teaching and

Confidence & Enjoyment in mathematics teaching.

5.3.4 Changes in Student Teacher's Attitude between Pre-TP and Post-TP

The last research question is: Do changes exist in student teacher's attitude between pre-TP and post-TP?

Attitudes Improvement: Though some researchers have said that teacher training has little or no impact on teachers' attitudes (e.g., Denscombe, 1982; Watson, 1987), there are substantial data found in this study that student teachers' attitude has improved. The study reveals three positive significant findings in attitude sub-scales, they are: Total Math Teaching Attitude, Confidence & Enjoyment and Desire for Recognition. For examples, CE students showed more concern about their image and recognition as outstanding Math teachers after TP than at the beginning of their course. It is surprising that CE students improved more than BEd students. CE students were more enthusiastic, confident in math teaching after studying a period of time at the HKIEd. Although student teachers' attitudes were slightly improved, whether the improvement in attitudes was a result of the programmes or natural student maturity or just due to a position change (from student to potential teacher) is still a puzzle. In this study, the researcher found that CE students experienced negative self-esteem because of their graduate status (non-degree teacher). They feel that they won't be recognized as good math teachers even if they teach math well, as they only have a teacher certificate, and they are not degree holders. Thus many CE students are eager to have immediate further studies by studying Mixed Mode BEd programmes or Add-on BEd Programmes after completing their CE courses. This could be a matter for concern if they use a university degree as the only criterion for assessing a teacher's teaching performance and their own self-value in the school. In addition, in Hong Kong, there are many primary schools which prefer to use the ratio of graduate teachers to non-graduate teachers as their school-quality indicator. This implies to the public that graduate teachers perform better than non-graduate teachers in primary school teaching. Thus, the responsibility of school heads and teacher training institutes to change this negative attitude of pre-service or new teachers needs to be considered. Furthermore, it is debatable, or at least worthy of investigation, whether a BEd degree in primary education is so important, as in this study the CE group had better PCK than the BEd group and both groups achieved similar scores in TP teaching. In addition, it is also of concern whether new teachers, without too much teaching experience, can handle the heavy teaching and studying workload simultaneously (this only concerns Mixed Mode

BEd students, as Add-on BEd students are full-time students). Does the Mixed Mode studying (part-time studying) affect his or her day-time teaching performance? If so, the programme structure or studying mode or entry criteria based on teaching experience of the applicants may need to be re-considered? Anyway, there are many other factors which would affect math teaching performance which are not discussed in this thesis. For instance, the researcher also has interests concerning whether:

- the ratio of pupils to teacher is appropriate to a teacher's teaching approach;
- resources devoted to teachers are enough, cost-effective and efficiently used;
- schools and parents can cooperate with teacher's teaching; and
- schools and teachers can match with Government's educational reform.

5.4 Recommendations

In summary, on the basis of this study, the researcher agrees that both pedagogical content knowledge (PCK) in mathematics and attitude towards mathematics teaching could help teachers to teach mathematics effectively. These findings are coherent with previous studies. For examples, Ball (1991) and Even (1993) found that mathematics teachers' teaching performance is highly correlated with their achievement in mathematics and attitudes toward mathematics. Besides, the researcher also found that teaching practice performance is highly correlated with students' PCK and also with their general mathematics attitudes. These findings are consistent with previous studies. However, insignificant correlations were found between SCK and teaching performance. The analysis reveals that student teachers' teaching performance is not significantly affected by their SCK. Besides, there are also no significant relationships found between student teacher' SCK and PCK. These distinctive findings are different from Ball (1991) and Shulman (1986)'s assumption that teacher's pedagogical content knowledge (PCK) is strongly influenced by their subject content knowledge (SCK). All these findings are worth further investigation for the purpose of developing a series of recommendations for reforming the teacher training policy.

On the whole, the study has revealed PCK and general teaching attitude as two important factors that affect the teaching performance most. Once reviewing the collected data, there are two immediate issues that emerged from these findings. The first issue is that although student teachers' PCK is better than pass and their attitudes toward math teaching is positive, they are just slightly above the minimum requirement, they are not as good as the researcher expected. The second issue is that due to insignificant correlation found between student teachers' SCK and PCK, it is risky to continue using student teachers' previous public examination results as the main factor for selecting student teachers in BEd and CE programmes. As a consequence, revising the entrance requirement of teacher training courses, how to improve student teachers' PCK and attitude towards mathematics teaching, restructuring teacher-training curriculum become major issues in math teacher professionalism. In order to nurture our primary mathematics teachers with positive attitude and adequate PCK, the curriculum of present mathematics teacher training programmes should be revised. As stated in 5.3.3, some additional aims should be involved in some modules. For instance, because of the rapid growth of information technology (IT), IT is also being explored as a tool for improving education quality. Applying IT effectively in teaching should be considered as another Pedagogical Content Knowledge (PCK). Therefore, the objectives in the current primary mathematics teacher training programme can no longer meet the demands of the recent societal development, mathematics educators and institutions should provide updated knowledge and information on the recent development of mathematics education as well as affective factors and teaching strategies of mathematics so as to boost our teachers' professionalism.

Clearly the study of competency in mathematics teaching is a difficult and indefinable task. Although, in this study, the researcher has got a clear conclusion that PCK and attitude are positively correlated with mathematics teaching performance, there are still so many factors that might affect the performance of teaching. Moreover, although there no significant effect was found from SCK on teaching performance and CE student teachers got slightly better results in teaching practice than BEd student teachers, it doesn't imply that teachers with positive attitudes without sufficient SCK can achieve sound PCK and can do the primary math teaching well. By these findings, it only illuminates that the minimum subject requirement for BEd (primary) math students should be revised to O-level pass. In this study even for those student teachers categorized as low achievers in math (LAM), this doesn't mean that they are unknowledgeable in math, especially the relevant aspects of primary mathematics. There is no doubt that they are able to solve all relevant math problems. Even students classified as LAM, all have passed O-level mathematics and even some of them had got credit or distinction in HKCEE mathematics. Besides, after entering the HKIEd, they still have the opportunity to study more mathematics. Therefore whether they can achieve more knowledge in both SCK and PCK in mathematics, mainly depends on their learning attitude. For that reason it would be foolish to assume that LAM student teachers' achievements in subject matter learning and PCK are comparably worse than HAM students after studying in the HKIEd. Thus developing their learning attitudes and attitudes toward teaching become the major factors that affect the quality of our future primary math teachers. On the whole, a competent math teacher must be knowledgeable, with sound PCK and with positive attitudes about the subject they are teaching. In addition, although we found statistically significant differences between the pre-TP and the post-TP in 'General Math Attitudes', 'Confidence & Enjoyment' and 'Pressure to Conform' scales, there is still room for improvement in all 5 scales, especially 'Anxiety' and 'Desire for Recognition'. Besides, there is no assessment mode for measuring student teachers' Pre-TP PCK level; thus the researcher cannot confidently conclude that the present teacher training programmes offered by the HKIEd make a measurable, obvious and notable improvement in student teachers' PCK. Thus the institute should consolidate the work of assessment, develop a series of assessment mechanisms for assessing student teachers' subject matter knowledge, pedagogical content knowledge and attitudes toward mathematics.

Recommendations

The implications derived from this study, although far from being conclusive, suggest certain directions for further investigation. For example, all the queries raised immediately above concern important factors in achieving quality primary mathematics teachers; and which merit further investigation. More immediately, it is recommended that the government should encourage teachers, schools, teacher training institutes, curriculum planners and even the textbook publishers to collaborate for the purposes of improving the effectiveness of teaching and improving teachers' teaching competency. For instance, all need to understand the importance of pedagogical content knowledge (PCK) and of attitude towards mathematics teaching. They need to design and provide appropriate programmes, modules for preservice and in-service mathematics teachers to improve their attitudes and PCK in math teaching. Besides, schools and government should provide appropriate material support to teachers for improving the effectiveness of teaching. For example, teachers need resources in the form of teaching aids, reference books, professional journals and also the opportunities for further studies and attending relevant conferences and seminars for assisting them in the development of their PCK and these materials can also help them create ideal learning environments for their pupils.

In addition, seven specific recommendations arise from the previous discussion in relation to the training of math student teachers, as follows:

1 Besides covering mathematical subject knowledge, curriculum and methodology, programmes for student teachers should include modules written for designing of / discussion on pedagogical content knowledge on specific mathematics concepts and skills. Thus, such modules may focus on the teaching and learning process on the selected topics of the five major primary mathematics streams: Number, Algebra, Shape & Space, Measures and Data Handling.

2 Within teacher training institutions, besides teaching practice, there should be another assessment mode for assessing student teachers' PCK for the purpose of motivating student teachers to increase their awareness of the importance of PCK and also to help them to achieve PCK. For instance, during some specific curriculum and methodology lessons, providing student teachers practical tests in which they are asked to explain the methodologies for teaching particular concepts either in writing or via verbal description. Besides, the current non-assessed pre-teaching practice workshop (in the HKIEd) is recommended to be assessed so that this hands-on activity, trial teaching and evaluation, will be enhanced considerably.

3 As attitudes toward math teaching are also positively correlated with teaching performance, where possible in the teacher training institutions modules for student teachers should include more discussion on attitudes towards mathematics teaching for increasing student teachers' awareness of its value in mathematics teaching.

4 This investigation should be replicated with more year groups for BEd student teachers. It should involve all year groups of student teachers, so that we can reveal and investigate the development of attitudes and PCK among student teachers more precisely.

5 It is recommended that similar research be replicated for kindergarten and secondary student teachers, full time kindergarten, primary and secondary teachers, and, in the Hong Kong context, with questionnaires written in Chinese if necessary.

In summary, the "Basic Competencies" of a primary mathematics teacher have been defined but these conclusions have been drawn within the limitations of this study and the instruments used. Because of the nature of the study and the emphasis on quantitative outcomes, the data is only analyzed by statistical testing. More precisely, a qualitative based, longitudinal study for measuring student teachers' attitudes and PCK should be set up for further investigations. Case studies can be used as a follow-up investigation for deeper study of teachers' affective domain and pedagogical content knowledge in mathematics.

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Appendices

Appendix A: Questionnaire of Attitude toward Mathematics Teaching

- This is not a test. There are no right or wrong answers.
- We are trying to find out your personal feeling about mathematics teaching.

Please complete all sections.

- What you write will be treated confidentially.

Section I

Sex (Female or Male): ___________

Age: ___________

What programme are you enrolled in? (2PC / 3PC / ICTT/ 4BED / PGDE):_________

Studying Year (Yr 1 /Yr 2 / Yr 3 / Yr 4): ___________ Semester (1 / 2):_______

Taking Mathematics as your elective (Yes / No):__________

Have you studied mathematics at tertiary level prior to enrolling in Hong Kong Institute of Education? (Yes / No):______ If so, please state.___________

What was the highest level of mathematics you passed in public examination? (AL / ASL / SCL):________

Current Mathematics Teaching Practicum Result (Distinction / Pass / Fail): ________

Your responses to this questionnaire are confidential, but it is necessary to have a unique identification code for a follow up survey. Please print your identity code (up to 6 digits). Don't forget this code, it will be used in the follow-up survey. I.D. Code: (   )

Section II

The following are statements on teaching mathematics, about which your opinion is sought, please indicate the extent to which you agree or disagree with the statements by writing the number (1 / 2 / 3 / 4 / 5) in the relevant squares at the end of each statement.

1 means disagree strongly   2 means disagree

3 means undecided   4 means agree

5 means agree strongly

1. Generally I feel secure about the idea of teaching mathematics. ☐
2. Of the entire subjects, mathematics is the one I worry about most in teaching. ☐
3. It would make me happy to be recognized by other teachers as an excellent teacher of mathematics. ☐
4. I would get a sinking feeling if I came across a hard problem while teaching mathematics at practice teaching. ☐
5. I'd be proud to be the outstanding teacher of mathematics amongst my peers. ☐
6. The thought of teaching mathematics makes me feel restless, irritable and impatient. ☐
7. I would like the school pupils to r4ecognise me as a good teacher of mathematics. ☐
8. I am confident about the methods of teaching mathematics. ☐

9. Teaching mathematics at practice teaching makes me feel nervous. ☐

10. Being an outstanding teacher of mathematics would make me feel unpleasantly conspicuous. ☐

11. I have a lot of self-confidence when it comes to teaching mathematics. ☐

12. The thought of teaching mathematics makes me feel nervous. ☐

13. My peers would think I was strange if I was an outstanding teacher of mathematics. ☐

14. I feel at ease when I'm teaching mathematics at practice teaching. ☐

15. I would not want to let on that I was good at teaching mathematics. ☐

16. I enjoy the challenge of teaching a new and difficult concept in mathematics. ☐

17. I'm not the type of person who could teach mathematics very well. ☐

18. Time passes quickly when I'm teaching mathematics at practice teaching. ☐

19. Teaching mathematics at practice is enjoyable and stimulating to me. ☐

20. Mathematics is the subject I'm least confident about teaching. ☐

21. Teaching Mathematics doesn't scare me at all. ☐

22. I like teaching mathematics at practice teaching. ☐

Appendix B: TP Supervision Form Teaching

Appendix C: Sample of Student teachers' Scheme of Work and Lesson Plan

香港教育學院
The Hong Kong Institute of Education
Bachelor of Education (Honours)(Primary) Programme
(Four-year Full-time) YearThree
Progress of Mathematics Teaching Form

1. 填寫教學進度表後請與顧問教師討論其適切程度。
   After completing the Progress of Teaching Form, students are required to discuss with the teacher-consultants on its suitability and practicability.
2. 請於實習最後一天將原稿交顧問教師，將一份影印本存於實習檔案內。
   The original of this form should be submitted to the Teacher-Consultants by the end of the teaching practice, and students should keep a copy at the teaching practice file.
3. 各科年級分別需填寫進度表各一份。
   Students should use separate forms for different classes and subjects taught.

日期 Date	時間 Time	教學進度 Progress of Teaching				備註 Remarks
		課題 Topic	學生已有知識 Previous Knowledge	教學重點 Main Teaching Focus	教具 Teaching material	
19.11.01	1355-1430	11 和 12	✓ 10 以內的數	**(課程綱要 1.4)** ➢ 認識 11 是 10 多 1 ➢ 11 的基本加法組合 e.g. 9+2 , 8+3 , 7+4 , 6+5 , 5+6 , 4+7 , 3+8 , 2+9 ➢ 11 的基本減法組合	數字卡 金魚圖卡 蘋果圖卡	
20.11.01	1445-1520	11 和 12	✓ 11 以內的數	**(課程綱要 1.4)** ➢ 認識 12 是 10 多 2，11 多 1 ➢ 12 的基本加法組合 e.g. 9+3 , 8+4 , 7+5 , 6+6 , 5+7 , 4+8 , 3+9 ➢ 12 的基本減法組合	數字卡 水果磁粒	
21.11.01	1645-1720	13 和 14	✓ 12 以內的數	**(課程綱要 1.4)** ➢ 認識 13 是 10 多 3，12 多 1	魚兒磁粒 水果磁	

				➢ 13 的基本加法組合 e.g. 9+4 , 8+5 , 7+6 , 6+7 , 5+7 , 4+8 , 3+9 ➢ 13 的基本減法組合 ➢	粒	
22.11.01	1445-1520	13 和 14	✓ 13 以內的數	(課程綱要 1.4) ➢ 認識 14 是 10 多 4，13 多 1 ➢ 14 的基本加法組合 e.g. 9+5 , 8+6 , 7+7 , 6+8 , 5+9 ➢ 14 的基本減法組合	動物磁粒 數粒	
23.11.01	1355-1430	15 和 16	✓ 14 以內的數	(課程綱要 1.4) ➢ 認識 15 是 10 多 5，14 多 1 ➢ 15 的基本加法組合 e.g. 9+6 , 8+7 , 7+8 , 6+9 ➢ 15 的基本減法組合	動物磁粒 數粒	
24.11.01	0945-1030	15 和 16	✓ 15 以內的數	(課程綱要 1.4) ➢ 認識 16 是 10 多 6，15 多 1 ➢ 16 的基本加法組合 e.g. 9+7 , 8+8 , 7+9 ➢ 16 的基本減法組合	人物圖卡 數粒	
26.11.01	1355-1430	17 和 18	✓ 16 以內的數	(課程綱要 1.4) ➢ 認識 17 是 10 多 7，16 多 1 ➢ 17 的基本加法組合 e.g. 9+8 , 8+9 ➢ 17 的基本減法組合	人物圖卡	
27.11.01	1445-1520	17 和 18	✓ 17 以內的數	(課程綱要 1.4) ➢ 認識 18 是 10 多 8，17 多 1 ➢ 18 的基本加法組合:9+9 ➢ 18 的基本減法組合	小龜磁粒 魚兒磁粒	
28.11.01	1645-1720	再來算算	✓ 18 以內的數 ✓ 簡單加法	(課程綱要 1.3) ➢ 10 以內的連加法	數字卡	

29.11.01	1445-1520	再來算算	✓ 18 以內的加法 ✓ 10 以內的連加法	(課程綱要 1.3) ➢ 簡易口述應用題	數字卡	
3.12.01	1355-1430	19 和 20	✓ 18 以內的數	(課程綱要 1.4) ➢ 認識 19 是 10 多 9，18 多 1 ➢ 19 的基本加法組合：10+9 ➢ 19 的基本減法組合	數粒	
4.12.01	1445-1520	19 和 20	✓ 19 以內的數	(課程綱要 1.4) ➢ 認識 20 是 10 多 10，19 多 1 ➢ 20 的基本加法組合：10+10 ➢ 20 的基本減法組合	數粒	
5.12.01	1645-1720	順數和倒數	✓ 10 以內的順數和倒數 ✓ 20 以內的數	(課程綱要 1.4) ➢ 複習 1-10 以內的順數和倒數 ➢ 認識 11-20 的順數 (包括從 1 以外開始的順數，e.g. 6→7→8…)	20 以內的數卡 皮球	
6.12.01	1645-1720	順數和倒數	✓ 10 以內的順數和倒數 ✓ 20 以內的數	(課程綱要 1.4) ➢ 複習 1-20 的順數 ➢ 認識 11-20 的倒數	20 以內的數卡 皮球	
7.12.01	1355-1430	單數和雙數	✓ 10 以內的雙數和單數	(課程綱要 1.4) ➢ 複習 10 以內的雙數和單數 ➢ 認識 11-20 的雙數和單數	皮球	
8.12.01	0945-1030	單數和雙數	✓ 20 以內的雙數和單數	(課程綱要 1.4) ➢ 複習 1-20 以內的雙數和單數	皮球	
10.12.01	1355-1430	有趣的加法	✓ 20 以內的數	(課程綱要 1.4) ➢ 認識加法的交換性質：	畫紙	

			✓ 簡單加法	e.g. 3+4 = 4+3		
11.12.01	1445-1520	有趣的加法	✓ 20 以內的數 ✓ 簡單加法 ✓ 加法的交換性質	**(課程綱要 1.4)** ➢ 複習加法的交換性質	畫紙	
13.12.01	1445-1520	每 2 個一數	✓ 20 以內的數	**(課程綱要 1.4)** ➢ 認識 20 以內的 2 個一數 ➢ 認識由 2→4→6→…→20 的數數方法	人物圖卡 10 對筷子 魚兒圖卡 兔子圖卡 1-20 數字卡	
17.12.01	1355-1430	每 2 個一數	✓ 20 以內的數 ✓ 20 以內的 2 個一數	**(學校課程需要)** ➢ 認識 2 隻=1 對；4 隻=2 對…的概念	BB 鞋數對	
18.12.01	1445-1520	每 2 個一數	✓ 20 以內的數 ✓ 20 以內的 2 個一數	**(學校課程需要)** ➢ 認識 2 的乘法概念 e.g. 1 個 2 是 2，2 個 2 是 4， 3 個 2 是 6，4 個 2 是 8， 5 個 2 是 10，6 個 2 是 12， 7 個 2 是 14，8 個 2 是 16， 9 個 2 是 18，10 個 2 是 20。	BB 鞋數對	
19.12.01	1645-1720	來比較	✓ 按一種性質把物件比較、分類、排列次序	**(課程綱要 1.6)** ➢ 複習分類活動 ➢ 認識一一對應的數數方法	水果磁粒	
20.12.01	1445-1520	來比較	✓ 按一種性質把物件比	**(課程綱要 1.6)** ➢ 在零散的物件中，以一一對應的方法(把兩樣	水果磁粒	

			較、分類、排列次序	不同的物件用線連起來)，比較物件的多少		
3.01.02	1355-1430	溫習		➢ 複習：簡單立體圖形	立體圖形圖片 溫習工作紙	
4.01.02	1355-1430	溫習		➢ 複習：11-20 的基本加法組合	溫習工作紙	
7.01.02	1355-1430	遊公園	✓ 按一種性質把物件比較、分類、排列次序 ✓ 以一一對應的方法比較物件的多少	**(課程綱要 1.6)** ➢ 把物件一對一排列起來 ➢ 並以一一對應的方法比較兩件物件的多少	小豬圖卡 小羊圖卡 大歌紙	
8.01.02	1445-1520	遊公園	✓ 把物件一對一排列起來 ✓ 並以一一對應的方法比較兩件物件的多少	**(課程綱要 1.6)** ➢ 製作簡單的統計圖 ➢ 能從統計圖找出：「那一類多些」、「多出多少」	工作紙 圖畫紙 大歌紙	
9.01.02	1645-1720	溫習		➢ 複習：順數和倒數	皮球	
10.01.02	1445-1520	溫習		➢ 複習：雙數和單數	數字卡	
11.01.02	1355-1430	溫習		➢ 複習：每 2 個一數	水果磁粒	
12.01.02	1045-1130	溫習		➢ 複習：每 2 個一數	BB 鞋數對	

Lesson Plan

科目：數學課題：分數的認識(二)
級別：小學三年級下學期教節：一教節(35 分鐘)
姓名：
班級：2PC2

學生已有知識 (Previous Knowledge)：

1. 學生已學習用分數表示圖形中某部分佔整體的多少。
2. 學生已學習分數的讀法和寫法。

教學目的(Teaching Objectives)：

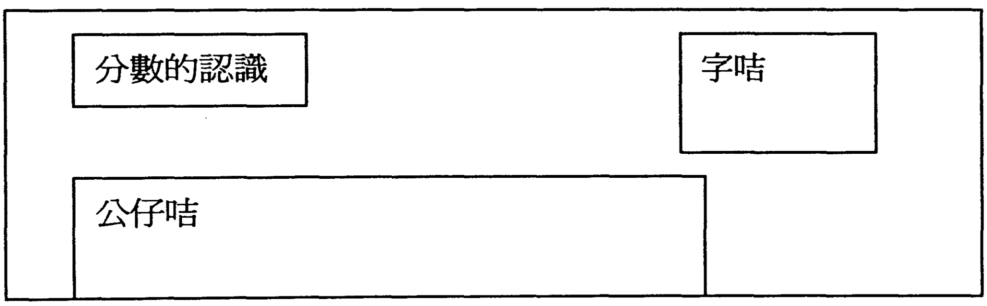
完成本教節後，學生能夠：

1. 用分數說出一組物件中某部分佔全部的多少。
2. 用分數說出一組物件的幾分之一是多少，包括：1/2、1/3、1/4。

教具(Teaching Aids)：

紅蘋果 3 個、青蘋果 2 個、公仔咭(3 款共 22 張)、字咭

黑板處理(Blackboard Arrangement)：



教學反思(Self-teaching Reflection)：

教學程序(Teaching Procedure)：

時間 Time	教學程序 Stages	教學活動 Teaching Activities	講述/提問/指示 Teaching content: Lecture/ Questioning/ Instruction	教學安排 Arrangement
3'	1.引起動機 (Motivation)	實物舉例 (Using real objects as examples)	教師拿著 3 個紅蘋果及 2 個青蘋果 提問： 1. 這裡一共有多少個蘋果?(5 個)(5apples) 2. 紅蘋果一共有多少個?(3 個) 3. 那麼青蘋果呢?(2 個) 講述： 這裡一共有 5 個蘋果，紅蘋果佔全部蘋果的 3/5，而青蘋果佔全部蘋果 2/5。	拿出紅蘋果及青蘋果 板貼課題 板書 3/5 及 2/5 的寫法及讀法。
4'	3. 發展 (Development) a.用分數說出一組物件中某部分佔全部的多少 Use fraction to express some realistic situations A	舉例	教師著 6 位同學出來，然後提問 1. 這裡一共有多少位同學?(6 個) 2. 當中多少人是戴眼鏡?(4 個) 3. 當中多少人沒有戴眼鏡?(2 個)	著學生在黑板寫出答案
3'			~著同學分別在黑板寫出有戴眼鏡同學佔全部同學的幾分之幾，以及沒有戴眼鏡同學佔幾分之幾。	
4'		鞏固活動 Consolidation via activities 畫圈分物	著同學做工作紙的第一部分，然後對答案	做工作紙 著同學在黑板畫圈
	b.用分數說出一組物件的幾分之一 Use fraction to express some realistic situations B		教師板貼 4 張公仔咭，然後著同學在黑板等分為 2 份 提問： 1. 當 4 張公仔咭等分為 2 份，1 份有多少個?(2 個) 2. 講述： a.由此可見，4 的 1/2 是 2 b.分子表示其中的一份，而分母表示所等分的份數。	板貼寫法 4 的 1/2 是 2 及分子分母字咭。
4'		畫圈分物		板貼公仔

				咭
4’		畫圈分物	教師板貼 6 張公仔咭，然後著同學在黑板等分爲(圈出)3 份 提問： 1. 把 6 張公仔咭等分爲 3 份，1 份有多少個?(2 個) 講述： 由此可見，6 的 1/3 是 2	板貼寫法 6 的 1/3 是 2
			指示： 1. 教師現在有 12 張公仔咭，同學可否將公仔咭等分爲 3 份，然後板貼在黑板上。	教師在黑板畫 3 個圈，然後著同學板貼公仔咭
8’			提問： 同學把 12 張公仔咭等分爲 4 份，1 份有多少個?(3 個)	板貼寫法 12 的 1/4 是
5’		鞏固活動 (consolidation activity)	講述： 由此可見，12 的 1/4 是 3 著同學做工作紙的第二至四部分，然後對答案	做工作紙
	3.總結 Conclusion		講述： 今日大家學會了用分數說出一組物件中某部分佔全部的多少，以及用分數說出一組物件的幾分之一(1/2、1/3、1/4)。	
	4. 應用 Application	著學生回家完成作業(十八) Request students to do Ex 18 as their homework	提問： 1. 我們下一堂會有一個分組活動，同學可否於下次告訴老師，如果將全班同學(40 人)分別分爲 8 組，每組會有多少人呢?	

Appendix D: Correlations between Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK)

Correlations

		SCK	PCK
SCK	Pearson Correlation	1.000	.083
	Sig. (2-tailed)	.	.759
	N	16	16
PCK	Pearson Correlation	.083	1.000
	Sig. (2-tailed)	.759	.
	N	16	16

Correlations between SCK and PCK of BEd students

Correlations

		SCK	PCK
SCK	Pearson Correlation	1.000	-.054
	Sig. (2-tailed)	.	.843
	N	16	16
PCK	Pearson Correlation	-.054	1.000
	Sig. (2-tailed)	.843	.
	N	16	16

Correlations between SCK and PCK of CE students

Correlations

		SCK	PCK
SCK	Pearson Correlation	1.000	.023
	Sig. (2-tailed)	.	.900
	N	32	32
PCK	Pearson Correlation	.023	1.000
	Sig. (2-tailed)	.900	.
	N	32	32

Correlations between SCK and PCK of BEd and CE students

Appendix E: T-Test Ratings Examining the Effectiveness of Training Programme on PCK Achievement

Group Statistics

	YEAR	N	Mean	Std. Deviation	Std. Error Mean
PCK	1	8	2.75	1.16	.41
	3	8	3.25	1.91	.67
SCK	1	8	1.63	.52	.18
	3	8	1.38	.52	.18
TPRESULT	1	8	3.00	.93	.33
	3	8	3.00	1.31	.46

Independent Samples Test

		Levene's Test for quality of Variance		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PCK	Equal variances assum	12.600	.003	-.632	14	.537	-.50	.79	-2.20	1.20
	Equal variances not assumed			-.632	11.580	.539	-.50	.79	-2.23	1.23
SCK	Equal variances assum	.000	1.000	.966	14	.350	.25	.26	-.31	.81
	Equal variances not assumed			.966	14.000	.350	.25	.26	-.31	.81
TPRESULT	Equal variances assum	.636	.438	.000	14	1.000	.00	.57	-1.22	1.22
	Equal variances not assumed			.000	12.600	1.000	.00	.57	-1.23	1.23

T-Test on BEd Yr 1 and Yr 3 students on PCK, SCK and TP performance

Group Statistics

	YEAR	N	Mean	Std. Deviation	Std. Error Mean
SCK	1	8	1.63	.52	.18
	2	8	1.38	.52	.18
PCK	1	8	2.88	1.13	.40
	2	8	3.75	1.16	.41
TPRESULT	1	8	2.63	1.06	.38
	2	8	3.38	.74	.26

Independent Samples Test

		Levene's Test for quality of Variance		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCK	Equal variances assu	.000	1.000	.966	14	.350	.25	.26	-.31	.81
	Equal variances not assumed			.966	14.000	.350	.25	.26	-.31	.81
PCK	Equal variances assu	.206	.657	-1.528	14	.149	-.88	.57	-2.10	.35
	Equal variances not assumed			-1.528	13.984	.149	-.88	.57	-2.10	.35
TPRESULT	Equal variances assu	1.400	.256	-1.637	14	.124	-.75	.46	-1.73	.23
	Equal variances not assumed			-1.637	12.546	.126	-.75	.46	-1.74	.24

T-Test on CE Yr 1 and Yr 2 students on PCK, SCK and TP performance

Appendix F: T-Test Results Examining the Gender Difference on PCK Achievement

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
PCK	1	8	3.13	1.36	.48
	2	8	3.50	1.07	.38
SCK	1	8	1.63	.52	.18
	2	8	1.38	.52	.18
TPRESULT	1	8	2.75	1.16	.41
	2	8	3.25	.71	.25

Independent Samples Test

		Levene's Test for quality of Variance		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PCK	Equal variances assu	1.092	.314	-.614	14	.549	-.38	.61	-1.68	.93
	Equal variances not assumed			-.614	13.276	.549	-.38	.61	-1.69	.94
SCK	Equal variances assu	.000	1.000	.966	14	.350	.25	.26	-.31	.81
	Equal variances not assumed			.966	14.000	.350	.25	.26	-.31	.81
TPRESULT	Equal variances assu	4.342	.056	-1.038	14	.317	-.50	.48	-1.53	.53
	Equal variances not assumed			-1.038	11.541	.321	-.50	.48	-1.55	.55

T-Test on CE male and female students on PCK, SCK and TP performance

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
SCK	1	7	1.57	.53	.20
	2	9	1.44	.53	.18
PCK	1	7	1.57	.53	.20
	2	9	4.11	1.05	.35
TPRESULT	1	7	2.14	.69	.26
	2	9	3.67	.87	.29

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCK	Equal variances assume	.014	.906	.475	14	.642	.13	.27	-.45	.70
	Equal variances not assumed			.474	12.951	.643	.13	.27	-.45	.71
PCK	Equal variances assume	1.504	.240	-5.791	14	.000	-2.54	.44	-3.48	-1.60
	Equal variances not assumed			-6.266	12.363	.000	-2.54	.41	-3.42	-1.66
TPRESULT	Equal variances assume	.543	.473	-3.802	14	.002	-1.52	.40	-2.38	-.66
	Equal variances not assumed			-3.917	13.975	.002	-1.52	.39	-2.36	-.69

T-Test on BEd male and female students on PCK, SCK and TP performance

Appendix G: Results and Analysis of Measured Attitude Means

i) Pre-TP Attitude for BEd and CE Student Teachers

Statistics

		Overal Attitude	ANXIETY	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
N	Valid	96	103	101	104	100
	Missing	8	1	3	0	4
Mean		68.0521	23.7184	24.8713	11.0288	8.3400
Std. Deviation		6.1923	4.4290	4.1174	1.8719	1.5777
Range		27.00	18.00	20.00	8.00	7.00
Minimum		56.00	14.00	14.00	7.00	5.00
Maximum		83.00	32.00	34.00	15.00	12.00

Overall Attitude Toward Math Teaching

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	56.00	1	1.0	1.0	1.0
	57.00	1	1.0	1.0	2.1
	59.00	1	1.0	1.0	3.1
	60.00	7	6.7	7.3	10.4
	61.00	4	3.8	4.2	14.6
	62.00	11	10.6	11.5	26.0
	63.00	3	2.9	3.1	29.2
	64.00	1	1.0	1.0	30.2
	65.00	8	7.7	8.3	38.5
	66.00	3	2.9	3.1	41.7
	67.00	7	6.7	7.3	49.0
	68.00	9	8.7	9.4	58.3
	69.00	2	1.9	2.1	60.4
	70.00	3	2.9	3.1	63.5
	71.00	10	9.6	10.4	74.0
	72.00	3	2.9	3.1	77.1
	73.00	6	5.8	6.3	83.3
	74.00	2	1.9	2.1	85.4
	75.00	3	2.9	3.1	88.5
	78.00	2	1.9	2.1	90.6
	79.00	1	1.0	1.0	91.7
	80.00	7	6.7	7.3	99.0
	83.00	1	1.0	1.0	100.0
	Total	96	92.3	100.0	
Missing	System	8	7.7		
Total		104	100.0		

ANXIETY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14.00	2	1.9	1.9	1.9
	16.00	5	4.8	4.9	6.8
	17.00	1	1.0	1.0	7.8
	18.00	4	3.8	3.9	11.7
	19.00	5	4.8	4.9	16.5
	20.00	12	11.5	11.7	28.2
	21.00	3	2.9	2.9	31.1
	22.00	9	8.7	8.7	39.8
	23.00	11	10.6	10.7	50.5
	24.00	7	6.7	6.8	57.3
	25.00	11	10.6	10.7	68.0
	26.00	2	1.9	1.9	69.9
	27.00	7	6.7	6.8	76.7
	28.00	7	6.7	6.8	83.5
	29.00	3	2.9	2.9	86.4
	30.00	5	4.8	4.9	91.3
	31.00	8	7.7	7.8	99.0
	32.00	1	1.0	1.0	100.0
	Total	103	99.0	100.0	
Missing	System	1	1.0		
Total		104	100.0		

Confidence & Enjoyment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14.00	1	1.0	1.0	1.0
	16.00	2	1.9	2.0	3.0
	17.00	1	1.0	1.0	4.0
	18.00	3	2.9	3.0	6.9
	19.00	1	1.0	1.0	7.9
	20.00	8	7.7	7.9	15.8
	21.00	8	7.7	7.9	23.8
	22.00	10	9.6	9.9	33.7
	23.00	5	4.8	5.0	38.6
	24.00	5	4.8	5.0	43.6
	25.00	6	5.8	5.9	49.5
	26.00	5	4.8	5.0	54.5
	27.00	17	16.3	16.8	71.3
	28.00	10	9.6	9.9	81.2
	29.00	10	9.6	9.9	91.1
	30.00	2	1.9	2.0	93.1
	31.00	3	2.9	3.0	96.0
	32.00	2	1.9	2.0	98.0
	33.00	1	1.0	1.0	99.0
	34.00	1	1.0	1.0	100.0
	Total	101	97.1	100.0	
Missing	System	3	2.9		
Total		104	100.0		

Desire for Recognition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7.00	5	4.8	4.8	4.8
	8.00	2	1.9	1.9	6.7
	9.00	17	16.3	16.3	23.1
	10.00	14	13.5	13.5	36.5
	11.00	22	21.2	21.2	57.7
	12.00	27	26.0	26.0	83.7
	13.00	4	3.8	3.8	87.5
	14.00	10	9.6	9.6	97.1
	15.00	3	2.9	2.9	100.0
	Total	104	100.0	100.0	

Pressure to Conform

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5.00	6	5.8	6.0	6.0
	6.00	8	7.7	8.0	14.0
	7.00	14	13.5	14.0	28.0
	8.00	18	17.3	18.0	46.0
	9.00	35	33.7	35.0	81.0
	10.00	11	10.6	11.0	92.0
	11.00	7	6.7	7.0	99.0
	12.00	1	1.0	1.0	100.0
	Total	100	96.2	100.0	
Missing	System	4	3.8		
Total		104	100.0		

Q1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.0	1.0	1.0
	2	11	10.7	10.8	11.8
	3	53	51.5	52.0	63.7
	4	35	34.0	34.3	98.0
	5	2	1.9	2.0	100.0
	Total	102	99.0	100.0	
Missing	System	1	1.0		
Total		103	100.0		

Q2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	12	11.7	11.7	11.7
	2	44	42.7	42.7	54.4
	3	18	17.5	17.5	71.8
	4	26	25.2	25.2	97.1
	5	3	2.9	2.9	100.0
	Total	103	100.0	100.0	

Q3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	5.8	5.8	5.8
	2	2	1.9	1.9	7.8
	3	31	30.1	30.1	37.9
	4	53	51.5	51.5	89.3
	5	11	10.7	10.7	100.0
	Total	103	100.0	100.0	

Q4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.9	1.9	1.9
	2	19	18.4	18.4	20.4
	3	34	33.0	33.0	53.4
	4	36	35.0	35.0	88.3
	5	12	11.7	11.7	100.0
	Total	103	100.0	100.0	

Q5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	10	9.7	9.7	9.7
	3	36	35.0	35.0	44.7
	4	46	44.7	44.7	89.3
	5	11	10.7	10.7	100.0
	Total	103	100.0	100.0	

Q6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	11	10.7	10.7	10.7
	2	23	22.3	22.3	33.0
	3	50	48.5	48.5	81.6
	4	17	16.5	16.5	98.1
	5	2	1.9	1.9	100.0
	Total	103	100.0	100.0	

Q7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.0	1.0	1.0
	2	3	2.9	2.9	3.9
	3	24	23.3	23.3	27.2
	4	58	56.3	56.3	83.5
	5	17	16.5	16.5	100.0
	Total	103	100.0	100.0	

Q8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	6.8	6.8	6.8
	2	25	24.3	24.3	31.1
	3	50	48.5	48.5	79.6
	4	20	19.4	19.4	99.0
	5	1	1.0	1.0	100.0
	Total	103	100.0	100.0	

Q9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.0	1.0	1.0
	2	31	30.1	30.1	31.1
	3	39	37.9	37.9	68.9
	4	32	31.1	31.1	100.0
	Total	103	100.0	100.0	

Q10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	4.9	4.9	4.9
	2	30	29.1	29.4	34.3
	3	55	53.4	53.9	88.2
	4	12	11.7	11.8	100.0
	Total	102	99.0	100.0	
Missing	System	1	1.0		
Total		103	100.0		

Q11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	9	8.7	8.7	8.7
	2	26	25.2	25.2	34.0
	3	45	43.7	43.7	77.7
	4	22	21.4	21.4	99.0
	5	1	1.0	1.0	100.0
	Total	103	100.0	100.0	

Q12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	12	11.7	11.7	11.7
	2	25	24.3	24.3	35.9
	3	40	38.8	38.8	74.8
	4	25	24.3	24.3	99.0
	5	1	1.0	1.0	100.0
	Total	103	100.0	100.0	

Q13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	2.9	2.9	2.9
	2	36	35.0	35.0	37.9
	3	45	43.7	43.7	81.6
	4	14	13.6	13.6	95.1
	5	5	4.9	4.9	100.0
	Total	103	100.0	100.0	

Q14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.9	2.0	2.0
	2	23	22.3	22.5	24.5
	3	46	44.7	45.1	69.6
	4	31	30.1	30.4	100.0
	Total	102	99.0	100.0	
Missing	System	1	1.0		
Total		103	100.0		

Q15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.9	2.0	2.0
	2	28	27.2	28.0	30.0
	3	62	60.2	62.0	92.0
	4	7	6.8	7.0	99.0
	5	1	1.0	1.0	100.0
	Total	100	97.1	100.0	
Missing	System	3	2.9		
Total		103	100.0		

Q16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.9	1.9	1.9
	2	21	20.4	20.4	22.3
	3	46	44.7	44.7	67.0
	4	31	30.1	30.1	97.1
	5	3	2.9	2.9	100.0
	Total	103	100.0	100.0	

Q17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	3.9	3.9	3.9
	2	30	29.1	29.1	33.0
	3	34	33.0	33.0	66.0
	4	27	26.2	26.2	92.2
	5	8	7.8	7.8	100.0
	Total	103	100.0	100.0	

Q18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.0	1.0	1.0
	2	8	7.8	7.8	8.8
	3	67	65.0	65.7	74.5
	4	24	23.3	23.5	98.0
	5	2	1.9	2.0	100.0
	Total	102	99.0	100.0	
Missing	System	1	1.0		
Total		103	100.0		

Q19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.0	1.0	1.0
	2	7	6.8	6.8	7.8
	3	37	35.9	35.9	43.7
	4	55	53.4	53.4	97.1
	5	3	2.9	2.9	100.0
	Total	103	100.0	100.0	

Q20

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	6.8	6.8	6.8
	2	20	19.4	19.4	26.2
	3	54	52.4	52.4	78.6
	4	21	20.4	20.4	99.0
	5	1	1.0	1.0	100.0
	Total	103	100.0	100.0	

Q21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.9	2.0	2.0
	2	24	23.3	23.5	25.5
	3	43	41.7	42.2	67.6
	4	24	23.3	23.5	91.2
	5	9	8.7	8.8	100.0
	Total	102	99.0	100.0	
Missing	System	1	1.0		
Total		103	100.0		

Q22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.9	1.9	1.9
	2	8	7.8	7.8	9.7
	3	53	51.5	51.5	61.2
	4	31	30.1	30.1	91.3
	5	9	8.7	8.7	100.0
	Total	103	100.0	100.0	

ii) Pre-TP Attitude for BEd student teachers

Statistics

		ANXIETY	CONFIDEN	DES4RECG	PRESSURE
N	Valid	102	101	103	100
	Missing	1	2	0	3
Mean		23.7549	21.8614	11.0000	8.3400
Std. Deviation		4.4353	3.7684	1.8577	1.5777
Range		18.00	18.00	8.00	7.00
Minimum		14.00	13.00	7.00	5.00
Maximum		32.00	31.00	15.00	12.00

ANXIETY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16.00	2	3.8	3.9	3.9
	18.00	2	3.8	3.9	7.8
	19.00	2	3.8	3.9	11.8
	20.00	4	7.7	7.8	19.6
	21.00	1	1.9	2.0	21.6
	22.00	3	5.8	5.9	27.5
	23.00	6	11.5	11.8	39.2
	24.00	3	5.8	5.9	45.1
	25.00	6	11.5	11.8	56.9
	26.00	1	1.9	2.0	58.8
	27.00	4	7.7	7.8	66.7
	28.00	5	9.6	9.8	76.5
	29.00	2	3.8	3.9	80.4
	30.00	4	7.7	7.8	88.2
	31.00	5	9.6	9.8	98.0
	32.00	1	1.9	2.0	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

CONFIDEN

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15.00	2	3.8	3.9	3.9
	16.00	2	3.8	3.9	7.8
	17.00	3	5.8	5.9	13.7
	18.00	2	3.8	3.9	17.6
	19.00	7	13.5	13.7	31.4
	20.00	5	9.6	9.8	41.2
	21.00	1	1.9	2.0	43.1
	22.00	5	9.6	9.8	52.9
	23.00	7	13.5	13.7	66.7
	24.00	7	13.5	13.7	80.4
	25.00	2	3.8	3.9	84.3
	26.00	3	5.8	5.9	90.2
	27.00	3	5.8	5.9	96.1
	28.00	2	3.8	3.9	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

DES4RECG

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7.00	2	3.8	3.8	3.8
	9.00	9	17.3	17.3	21.2
	10.00	8	15.4	15.4	36.5
	11.00	14	26.9	26.9	63.5
	12.00	12	23.1	23.1	86.5
	14.00	6	11.5	11.5	98.1
	15.00	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

PRESSURE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5.00	3	5.8	6.0	6.0
	6.00	3	5.8	6.0	12.0
	7.00	6	11.5	12.0	24.0
	8.00	8	15.4	16.0	40.0
	9.00	21	40.4	42.0	82.0
	10.00	6	11.5	12.0	94.0
	11.00	3	5.8	6.0	100.0
	Total	50	96.2	100.0	
Missing	System	2	3.8		
Total		52	100.0		

Q1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	7	13.5	13.7	13.7
	3	25	48.1	49.0	62.7
	4	18	34.6	35.3	98.0
	5	1	1.9	2.0	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

Q2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	9.6	9.6	9.6
	2	17	32.7	32.7	42.3
	3	10	19.2	19.2	61.5
	4	19	36.5	36.5	98.1
	5	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Q3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	3.8	3.8	3.8
	3	16	30.8	30.8	34.6
	4	30	57.7	57.7	92.3
	5	4	7.7	7.7	100.0
	Total	52	100.0	100.0	

Q4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	8	15.4	15.4	15.4
	3	18	34.6	34.6	50.0
	4	18	34.6	34.6	84.6
	5	8	15.4	15.4	100.0
	Total	52	100.0	100.0	

Q5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	7	13.5	13.5	13.5
	3	20	38.5	38.5	51.9
	4	19	36.5	36.5	88.5
	5	6	11.5	11.5	100.0
	Total	52	100.0	100.0	

Q6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	5.8	5.8	5.8
	2	12	23.1	23.1	28.8
	3	29	55.8	55.8	84.6
	4	8	15.4	15.4	100.0
	Total	52	100.0	100.0	

Q7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	13	25.0	25.0	25.0
	4	32	61.5	61.5	86.5
	5	7	13.5	13.5	100.0
	Total	52	100.0	100.0	

Q8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	5.8	5.8	5.8
	2	12	23.1	23.1	28.8
	3	25	48.1	48.1	76.9
	4	12	23.1	23.1	100.0
	Total	52	100.0	100.0	

Q9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	13	25.0	25.0	25.0
	3	20	38.5	38.5	63.5
	4	19	36.5	36.5	100.0
	Total	52	100.0	100.0	

Q10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	5.8	5.9	5.9
	2	12	23.1	23.5	29.4
	3	30	57.7	58.8	88.2
	4	6	11.5	11.8	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

Q11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	5.8	5.8	5.8
	2	15	28.8	28.8	34.6
	3	24	46.2	46.2	80.8
	4	10	19.2	19.2	100.0
	Total	52	100.0	100.0	

Q12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	9.6	9.6	9.6
	2	8	15.4	15.4	25.0
	3	22	42.3	42.3	67.3
	4	16	30.8	30.8	98.1
	5	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Q13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	17	32.7	32.7	32.7
	3	27	51.9	51.9	84.6
	4	6	11.5	11.5	96.2
	5	2	3.8	3.8	100.0
	Total	52	100.0	100.0	

Q14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.9	2.0	2.0
	2	11	21.2	21.6	23.5
	3	23	44.2	45.1	68.6
	4	16	30.8	31.4	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

Q15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.9	2.0	2.0
	2	13	25.0	26.0	28.0
	3	33	63.5	66.0	94.0
	4	3	5.8	6.0	100.0
	Total	50	96.2	100.0	
Missing	System	2	3.8		
Total		52	100.0		

Q16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.9	1.9	1.9
	2	11	21.2	21.2	23.1
	3	25	48.1	48.1	71.2
	4	15	28.8	28.8	100.0
	Total	52	100.0	100.0	

Q17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	14	26.9	26.9	26.9
	3	16	30.8	30.8	57.7
	4	17	32.7	32.7	90.4
	5	5	9.6	9.6	100.0
	Total	52	100.0	100.0	

Q18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	5.8	5.8	5.8
	3	33	63.5	63.5	69.2
	4	15	28.8	28.8	98.1
	5	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Q19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	5.8	5.8	5.8
	3	20	38.5	38.5	44.2
	4	29	55.8	55.8	100.0
	Total	52	100.0	100.0	

Q20

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	9	17.3	17.3	17.3
	3	29	55.8	55.8	73.1
	4	14	26.9	26.9	100.0
	Total	52	100.0	100.0	

Q21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.9	2.0	2.0
	2	13	25.0	25.5	27.5
	3	25	48.1	49.0	76.5
	4	10	19.2	19.6	96.1
	5	2	3.8	3.9	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

Q22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	5	9.6	9.6	9.6
	3	30	57.7	57.7	67.3
	4	14	26.9	26.9	94.2
	5	3	5.8	5.8	100.0
	Total	52	100.0	100.0	

iii) Pre-TP Attitude Toward Math Teaching for CE Student Teachers Frequencies

Statistics

		Overall Attitude	ANXIETY	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
N	Valid	49	52	51	52	50
	Missing	3	0	1	0	2
Mean		66.8980	22.5192	25.0392	11.0577	8.2600
Std. Deviation		5.8781	4.2587	4.4089	1.9942	1.6759
Range		24.00	17.00	20.00	8.00	7.00
Minimum		56.00	14.00	14.00	7.00	5.00
Maximum		80.00	31.00	34.00	15.00	12.00

Overall Attitude Toward Math Teaching

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	56.00	1	1.9	2.0	2.0
	57.00	1	1.9	2.0	4.1
	60.00	4	7.7	8.2	12.2
	61.00	2	3.8	4.1	16.3
	62.00	8	15.4	16.3	32.7
	63.00	1	1.9	2.0	34.7
	65.00	4	7.7	8.2	42.9
	66.00	2	3.8	4.1	46.9
	67.00	4	7.7	8.2	55.1
	68.00	7	13.5	14.3	69.4
	69.00	1	1.9	2.0	71.4
	70.00	1	1.9	2.0	73.5
	71.00	5	9.6	10.2	83.7
	73.00	2	3.8	4.1	87.8
	74.00	1	1.9	2.0	89.8
	75.00	1	1.9	2.0	91.8
	79.00	1	1.9	2.0	93.9
	80.00	3	5.8	6.1	100.0
	Total	49	94.2	100.0	
Missing	System	3	5.8		
Total		52	100.0		

ANXIETY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14.00	2	3.8	3.8	3.8
	16.00	3	5.8	5.8	9.6
	17.00	1	1.9	1.9	11.5
	18.00	2	3.8	3.8	15.4
	19.00	3	5.8	5.8	21.2
	20.00	8	15.4	15.4	36.5
	21.00	2	3.8	3.8	40.4
	22.00	6	11.5	11.5	51.9
	23.00	5	9.6	9.6	61.5
	24.00	4	7.7	7.7	69.2
	25.00	5	9.6	9.6	78.8
	26.00	1	1.9	1.9	80.8
	27.00	3	5.8	5.8	86.5
	28.00	2	3.8	3.8	90.4
	29.00	1	1.9	1.9	92.3
	30.00	1	1.9	1.9	94.2
	31.00	3	5.8	5.8	100.0
	Total	52	100.0	100.0	

Confidence & Enjoyment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14.00	1	1.9	2.0	2.0
	16.00	1	1.9	2.0	3.9
	17.00	1	1.9	2.0	5.9
	18.00	1	1.9	2.0	7.8
	19.00	1	1.9	2.0	9.8
	20.00	3	5.8	5.9	15.7
	21.00	4	7.7	7.8	23.5
	22.00	4	7.7	7.8	31.4
	23.00	2	3.8	3.9	35.3
	24.00	4	7.7	7.8	43.1
	25.00	2	3.8	3.9	47.1
	26.00	2	3.8	3.9	51.0
	27.00	9	17.3	17.6	68.6
	28.00	6	11.5	11.8	80.4
	29.00	4	7.7	7.8	88.2
	30.00	1	1.9	2.0	90.2
	31.00	3	5.8	5.9	96.1
	33.00	1	1.9	2.0	98.0
	34.00	1	1.9	2.0	100.0
	Total	51	98.1	100.0	
Missing	System	1	1.9		
Total		52	100.0		

Desire for Recognition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7.00	3	5.8	5.8	5.8
	8.00	2	3.8	3.8	9.6
	9.00	8	15.4	15.4	25.0
	10.00	6	11.5	11.5	36.5
	11.00	8	15.4	15.4	51.9
	12.00	15	28.8	28.8	80.8
	13.00	4	7.7	7.7	88.5
	14.00	4	7.7	7.7	96.2
	15.00	2	3.8	3.8	100.0
	Total	52	100.0	100.0	

Pressure to Conform

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5.00	3	5.8	6.0	6.0
	6.00	5	9.6	10.0	16.0
	7.00	8	15.4	16.0	32.0
	8.00	10	19.2	20.0	52.0
	9.00	14	26.9	28.0	80.0
	10.00	5	9.6	10.0	90.0
	11.00	4	7.7	8.0	98.0
	12.00	1	1.9	2.0	100.0
	Total	50	96.2	100.0	
Missing	System	2	3.8		
Total		52	100.0		

Appendix H: T-Test on Various Attitudes Between CE and BEd Student Teachers

Group Statistics

	Programme	N	Mean	Std. Deviation	Std. Error Mean
ANXIETY	1	51	24.9412	4.3008	.6022
	2	52	22.5192	4.2587	.5906
CONFIDEN	1	50	24.7000	3.8346	.5423
	2	51	25.0392	4.4089	.6174
DES4RECG	1	52	11.0000	1.7601	.2441
	2	52	11.0577	1.9942	.2766
PRESSURE	1	50	8.4200	1.4859	.2101
	2	50	8.2600	1.6759	.2370
TOATTI	1	47	69.2553	6.3433	.9253
	2	49	66.8980	5.8781	.8397

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ANXIETY	Equal variances assumed	.123	.727	2.872	101	.005	2.4219	.8434	.7489	4.0950
	Equal variances not assumed			2.871	100.913	.005	2.4219	.8435	.7487	4.0952
CONFIDEN	Equal variances assumed	.644	.424	-.412	99	.681	-.3392	.8229	-1.9720	1.2935
	Equal variances not assumed			-.413	97.621	.681	-.3392	.8217	-1.9700	1.2915
DES4RECG	Equal variances assumed	1.611	.207	-.156	102	.876	-5.7692E-02	.3689	-.7893	.6739
	Equal variances not assumed			-.156	100.450	.876	-5.7692E-02	.3689	-.7895	.6741
PRESSURE	Equal variances assumed	.872	.353	.505	98	.615	.1600	.3167	-.4686	.7886
	Equal variances not assumed			.505	96.614	.615	.1600	.3167	-.4687	.7887
TOATTI	Equal variances assumed	.875	.352	1.890	94	.062	2.3574	1.2475	-.1196	4.8343
	Equal variances not assumed			1.887	92.709	.062	2.3574	1.2495	-.1240	4.8387

Statistics

		Overal Attitude	ANXIETY	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
N	Valid	96	103	101	104	100
	Missing	8	1	3	0	4
Mean		68.0521	23.7184	24.8713	11.0288	8.3400
Std. Deviation		6.1923	4.4290	4.1174	1.8719	1.5777
Range		27.00	18.00	20.00	8.00	7.00
Minimum		56.00	14.00	14.00	7.00	5.00
Maximum		83.00	32.00	34.00	15.00	12.00

Pre-TP Attitude Toward Math Teaching for BEd and CE Student Teachers

Statistics

		Overall Attitude	ANXIETY	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
N	Valid	47	51	50	52	50
	Missing	5	1	2	0	2
Mean		69.2553	24.9412	24.7000	11.0000	8.4200
Std. Deviation		6.3433	4.3008	3.8346	1.7601	1.4859
Range		24.00	16.00	16.00	8.00	6.00
Minimum		59.00	16.00	16.00	7.00	5.00
Maximum		83.00	32.00	32.00	15.00	11.00

Pre-TP Attitude Toward Math Teaching for BEd Student Teachers

Statistics

		Overall Attitude	ANXIETY	Confidence & Enjoyment	Desire for Recognition	Pressure to Conform
N	Valid	49	52	51	52	50
	Missing	3	0	1	0	2
Mean		66.8980	22.5192	25.0392	11.0577	8.2600
Std. Deviation		5.8781	4.2587	4.4089	1.9942	1.6759
Range		24.00	17.00	20.00	8.00	7.00
Minimum		56.00	14.00	14.00	7.00	5.00
Maximum		80.00	31.00	34.00	15.00	12.00

Pre-TP Attitude Toward Math Teaching for CE Student Teachers

Appendix I and J: Results of T-Tests on The First Year and The Third Year BEd Student Teachers' Responses to The Questionnaire of Attitudes Toward Mathematics Teaching

Appendix I : T-Test for BEd Yr1 and Yr 3 Students

Group Statistics

	YEAR	N	Mean	Std. Deviation	Std. Error Mean
TOATTI	1	25	67.8000	6.4679	1.2936
	3	22	70.9091	5.9113	1.2603
ANXIETY	1	26	23.4231	4.0117	.7868
	3	25	26.5200	4.0837	.8167
CONFIDEN	1	25	25.0000	4.4347	.8869
	3	25	24.4000	3.1885	.6377
DES4RECG	1	26	10.8462	1.8043	.3538
	3	26	11.1538	1.7365	.3406
PRESSURE	1	26	8.5000	1.5556	.3051
	3	24	8.3333	1.4346	.2928

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOATTI	Equal variances assumed	.144	.706	-1.711	45	.094	-3.1091	1.8166	-6.7679	.5498
	Equal variances not assumed			-1.722	44.926	.092	-3.1091	1.8060	-6.7468	.5286
ANXIETY	Equal variances assumed	.005	.945	-2.732	49	.009	-3.0969	1.1336	-5.3751	-.8188
	Equal variances not assumed			-2.731	48.837	.009	-3.0969	1.1340	-5.3761	-.8178
CONFIDEN	Equal variances assumed	2.318	.134	.549	48	.585	.6000	1.0924	-1.5964	2.7964
	Equal variances not assumed			.549	43.581	.586	.6000	1.0924	-1.6022	2.8022
DES4RECG	Equal variances assumed	.000	1.000	-.627	50	.534	-.3077	.4911	-1.2941	.6787
	Equal variances not assumed			-.627	49.927	.534	-.3077	.4911	-1.2941	.6788
PRESSURE	Equal variances assumed	.221	.640	.393	48	.696	.1667	.4243	-.6864	1.0197
	Equal variances not assumed			.394	48.000	.695	.1667	.4229	-.6836	1.0169

T-Test for BEd Yr1 and Yr 3 Students

Appendix J : T-Test for CE Yr 1 and the Final Yr Students

Group Statistics

	YEAR	N	Mean	Std. Deviation	Std. Error Mean
TOATTI	1	27	66.6667	6.0701	1.1682
	2	22	67.1818	5.7622	1.2285
ANXIETY	1	27	20.8519	3.3016	.6354
	2	25	26.4000	3.2404	.6481
CONFIDEN	1	27	25.1852	4.4379	.8541
	2	24	24.8750	4.4654	.9115
DES4RECG	1	27	9.3333	2.1839	.4203
	2	25	11.9200	1.4119	.2824
PRESSURE	1	27	7.9630	1.5059	.2898
	2	23	8.6087	1.8275	.3811

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOATTI	Equal variances assumed	.063	.803	-.302	47	.764	-.5152	1.7045	-3.9441	2.9138
	Equal variances not assumed			-.304	45.861	.763	-.5152	1.6953	-3.9278	2.8975
ANXIETY	Equal variances assumed	.004	.953	-6.109	50	.000	-5.5481	.9083	-7.3724	-3.7239
	Equal variances not assumed			-6.113	49.822	.000	-5.5481	.9076	-7.3713	-3.7250
CONFIDEN	Equal variances assumed	.050	.824	.248	49	.805	.3102	1.2487	-2.1991	2.8194
	Equal variances not assumed			.248	48.229	.805	.3102	1.2491	-2.2010	2.8214
DES4RECG	Equal variances assumed	5.767	.020	-5.027	50	.000	-2.5867	.5145	-3.6202	-1.5532
	Equal variances not assumed			-5.109	44.866	.000	-2.5867	.5063	-3.6066	-1.5668
PRESSURE	Equal variances assumed	1.393	.244	-1.370	48	.177	-.6457	.4713	-1.5934	.3020
	Equal variances not assumed			-1.349	42.717	.185	-.6457	.4788	-1.6114	.3200

T-Testfor CE 1st year and final year students

Appendix K: ANOVA analysis of differences in attitudes toward mathematics teaching for BEd students by gender.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean: Lower Bound	95% Confidence Interval for Mean: Upper Bound	Minimum	Maximum
TOATTI	1	20	69.5000	7.0450	1.5753	66.2029	72.7971	60.00	80.00
	2	27	69.0741	5.9026	1.1360	66.7391	71.4091	59.00	83.00
	Total	47	69.2553	6.3433	.9253	67.3928	71.1178	59.00	83.00
ANXIETY	1	20	24.5000	4.7517	1.0625	22.2761	26.7239	16.00	31.00
	2	31	25.2258	4.0391	.7254	23.7443	26.7073	18.00	32.00
	Total	51	24.9412	4.3008	.6022	23.7316	26.1508	16.00	32.00
CONFIDEN	1	20	25.3000	3.3261	.7437	23.7433	26.8567	20.00	29.00
	2	30	24.3000	4.1452	.7568	22.7522	25.8478	16.00	32.00
	Total	50	24.7000	3.8346	.5423	23.6102	25.7898	16.00	32.00
DES4RECG	1	20	11.2500	1.9702	.4405	10.3279	12.1721	7.00	14.00
	2	32	10.8438	1.6286	.2879	10.2566	11.4309	9.00	15.00
	Total	52	11.0000	1.7601	.2441	10.5100	11.4900	7.00	15.00
PRESSURE	1	20	8.4500	1.7006	.3803	7.6541	9.2459	5.00	11.00
	2	30	8.4000	1.3544	.2473	7.8942	8.9058	5.00	11.00
	Total	50	8.4200	1.4859	.2101	7.9977	8.8423	5.00	11.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TOATTI	Between Groups	2.084	1	2.084	.051	.823
	Within Groups	1848.852	45	41.086		
	Total	1850.936	46			
ANXIETY	Between Groups	6.404	1	6.404	.342	.562
	Within Groups	918.419	49	18.743		
	Total	924.824	50			
CONFIDEN	Between Groups	12.000	1	12.000	.813	.372
	Within Groups	708.500	48	14.760		
	Total	720.500	49			
DES4RECG	Between Groups	2.031	1	2.031	.651	.424
	Within Groups	155.969	50	3.119		
	Total	158.000	51			
PRESSURE	Between Groups	3.000E-02	1	3.000E-02	.013	.909
	Within Groups	108.150	48	2.253		
	Total	108.180	49			

ANOVA analysis of gender difference on math teaching attitude for all BEd students

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
TOATTI	1	10	67.7000	6.3779	2.0169	63.1375	72.2625	60.00	80.00
	2	15	67.8667	6.7493	1.7426	64.1291	71.6043	59.00	83.00
	Total	25	67.8000	6.4679	1.2936	65.1302	70.4698	59.00	83.00
ANXIETY	1	10	22.9000	4.4083	1.3940	19.7465	26.0535	16.00	31.00
	2	16	23.7500	3.8557	.9639	21.6954	25.8046	18.00	30.00
	Total	26	23.4231	4.0117	.7868	21.8027	25.0434	16.00	31.00
CONFIDEN	1	10	25.3000	3.4976	1.1060	22.7980	27.8020	20.00	29.00
	2	15	24.8000	5.0737	1.3100	21.9903	27.6097	16.00	32.00
	Total	25	25.0000	4.4347	.8869	23.1694	26.8306	16.00	32.00
DES4RECG	1	10	10.8000	2.2010	.6960	9.2255	12.3745	7.00	14.00
	2	16	10.8750	1.5864	.3966	10.0297	11.7203	9.00	14.00
	Total	26	10.8462	1.8043	.3538	10.1174	11.5749	7.00	14.00
PRESSURE	1	10	8.7000	1.8886	.5972	7.3490	10.0510	5.00	11.00
	2	16	8.3750	1.3601	.3400	7.6502	9.0998	6.00	11.00
	Total	26	8.5000	1.5556	.3051	7.8717	9.1283	5.00	11.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TOATTI	Between Groups	.167	1	.167	.004	.951
	Within Groups	1003.833	23	43.645		
	Total	1004.000	24			
ANXIETY	Between Groups	4.446	1	4.446	.268	.609
	Within Groups	397.900	24	16.579		
	Total	402.346	25			
CONFIDEN	Between Groups	1.500	1	1.500	.073	.789
	Within Groups	470.500	23	20.457		
	Total	472.000	24			
DES4RECG	Between Groups	3.462E-02	1	3.462E-02	.010	.920
	Within Groups	81.350	24	3.390		
	Total	81.385	25			
PRESSURE	Between Groups	.650	1	.650	.261	.614
	Within Groups	59.850	24	2.494		
	Total	60.500	25			

ANOVA analysis of gender difference on math teaching attitude for the first year BEd students

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
TOATTI	1	10	71.3000	7.5432	2.3854	65.9039	76.6961	61.00	80.00
	2	12	70.5833	4.4611	1.2878	67.7489	73.4178	65.00	78.00
	Total	22	70.9091	5.9113	1.2603	68.2882	73.5300	61.00	80.00
ANXIETY	1	10	26.1000	4.7481	1.5015	22.7034	29.4966	16.00	31.00
	2	15	26.8000	3.7264	.9621	24.7364	28.8636	18.00	32.00
	Total	25	26.5200	4.0837	.8167	24.8343	28.2057	16.00	32.00
CONFIDEN	1	10	25.3000	3.3350	1.0546	22.9143	27.6857	21.00	29.00
	2	15	23.8000	3.0519	.7880	22.1099	25.4901	20.00	29.00
	Total	25	24.4000	3.1885	.6377	23.0838	25.7162	20.00	29.00
DES4RECG	1	10	11.7000	1.7029	.5385	10.4818	12.9182	9.00	14.00
	2	16	10.8125	1.7212	.4303	9.8953	11.7297	9.00	15.00
	Total	26	11.1538	1.7365	.3406	10.4525	11.8552	9.00	15.00
PRESSURE	1	10	8.2000	1.5492	.4899	7.0918	9.3082	5.00	10.00
	2	14	8.4286	1.3986	.3738	7.6211	9.2361	5.00	10.00
	Total	24	8.3333	1.4346	.2928	7.7276	8.9391	5.00	10.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TOATTI	Between Groups	2.802	1	2.802	.077	.785
	Within Groups	731.017	20	36.551		
	Total	733.818	21			
ANXIETY	Between Groups	2.940	1	2.940	.170	.684
	Within Groups	397.300	23	17.274		
	Total	400.240	24			
CONFIDEN	Between Groups	13.500	1	13.500	1.347	.258
	Within Groups	230.500	23	10.022		
	Total	244.000	24			
DES4RECG	Between Groups	4.847	1	4.847	1.649	.211
	Within Groups	70.538	24	2.939		
	Total	75.385	25			
PRESSURE	Between Groups	.305	1	.305	.143	.709
	Within Groups	47.029	22	2.138		
	Total	47.333	23			

ANOVA analysis of gender difference on math teaching attitude for the third year BED students

Appendix L: Response patterns of the 3rd Year BEd student teachers in the scale of Confidence & Enjoyment

i) Response patterns on Confidence & Enjoyment for 3rd BEd female students

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
CONFIDEN	15	20.00	29.00	23.8000	3.0519
Valid N (listwise)	15				

Statistics

		Q8	Q11	Q14	Q16	Q18	Q19	Q21	Q22
N	Valid	16	16	15	16	16	16	16	16
	Missing	0	0	1	0	0	0	0	0

Q8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	37.5	37.5	37.5
	3	6	37.5	37.5	75.0
	4	4	25.0	25.0	100.0
	Total	16	100.0	100.0	

Q11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	37.5	37.5	37.5
	3	8	50.0	50.0	87.5
	4	2	12.5	12.5	100.0
	Total	16	100.0	100.0	

Q14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	6.3	6.7	6.7
	3	11	68.8	73.3	80.0
	4	3	18.8	20.0	100.0
	Total	15	93.8	100.0	
Missing	System	1	6.3		
Total		16	100.0		

Q16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	5	31.3	31.3	31.3
	3	7	43.8	43.8	75.0
	4	4	25.0	25.0	100.0
	Total	16	100.0	100.0	

Q18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	6.3	6.3	6.3
	3	11	68.8	68.8	75.0
	4	3	18.8	18.8	93.8
	5	1	6.3	6.3	100.0
	Total	16	100.0	100.0	

Q19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	6.3	6.3	6.3
	3	10	62.5	62.5	68.8
	4	5	31.3	31.3	100.0
	Total	16	100.0	100.0	

Q21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	6.3	6.3	6.3
	2	3	18.8	18.8	25.0
	3	10	62.5	62.5	87.5
	4	2	12.5	12.5	100.0
	Total	16	100.0	100.0	

Q22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	12.5	12.5	12.5
	3	11	68.8	68.8	81.3
	4	3	18.8	18.8	100.0
	Total	16	100.0	100.0	

ii) Response patterns on Confidence & Enjoyment for 3rd year BEd male students

Statistics

		CONFIDEN	DES4RECG
N	Valid	10	10
	Missing	0	0

CONFIDEN

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21.00	2	20.0	20.0	20.0
	22.00	2	20.0	20.0	40.0
	27.00	2	20.0	20.0	60.0
	28.00	3	30.0	30.0	90.0
	29.00	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

DES4RECG

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	9.00	2	20.0	20.0	20.0
	11.00	1	10.0	10.0	30.0
	12.00	5	50.0	50.0	80.0
	14.00	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Statistics

		Q8	Q11	Q14	Q16	Q18	Q19	Q21	Q22
N	Valid	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0

Q8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	20.0	20.0	20.0
	3	8	80.0	80.0	100.0
	Total	10	100.0	100.0	

Q11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	20.0	20.0	20.0
	3	5	50.0	50.0	70.0
	4	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Q14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	5	50.0	50.0	50.0
	4	5	50.0	50.0	100.0
	Total	10	100.0	100.0	

Q16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	20.0	20.0	20.0
	3	7	70.0	70.0	90.0
	4	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Q18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	7	70.0	70.0	70.0
	4	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Q19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	10	100.0	100.0	100.0

Q21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	4	40.0	40.0	40.0
	3	3	30.0	30.0	70.0
	4	2	20.0	20.0	90.0
	5	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Q22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	9	90.0	90.0	90.0
	5	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Appendix M: Response patterns of the 3rd Year BEd student teachers in the scale of Desire for Recognition

i) Response pattern on Desire for Recognition for 3rd Yr BEd male students

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DES4RECG	16	9.00	15.00	10.8125	1.7212
Valid N (listwise)	16				

Statistics

		Q3	Q5	Q7
N	Valid	16	16	16
	Missing	0	0	0

Q3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	5	31.3	31.3	31.3
	4	10	62.5	62.5	93.8
	5	1	6.3	6.3	100.0
	Total	16	100.0	100.0	

Q5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	12.5	12.5	12.5
	3	10	62.5	62.5	75.0
	4	2	12.5	12.5	87.5
	5	2	12.5	12.5	100.0
	Total	16	100.0	100.0	

Q7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	5	31.3	31.3	31.3
	4	9	56.3	56.3	87.5
	5	2	12.5	12.5	100.0
	Total	16	100.0	100.0	

ii) Response pattern on Desire for Recognition for 3rd Yr BEd females

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DES4RECG	10	9.00	14.00	11.7000	1.7029
Valid N (listwise)	10				

Statistics

		Q3	Q5	Q7
N	Valid	10	10	10
	Missing	0	0	0

Q3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	20.0	20.0	20.0
	4	7	70.0	70.0	90.0
	5	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Q5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	10.0	10.0	10.0
	3	2	20.0	20.0	30.0
	4	5	50.0	50.0	80.0
	5	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Q7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	20.0	20.0	20.0
	4	6	60.0	60.0	80.0
	5	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Appendix N: ANOVA analysis of differences in attitudes toward mathematics teaching -- CE students by gender.

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
TOATTI	1	19	67.7895	7.1070	1.6304
	2	30	66.3333	4.9989	.9127
ANXIETY	1	19	23.7368	4.5441	1.0425
	2	32	21.8750	4.0381	.7138
CONFIDEN	1	19	21.8947	3.1780	.7291
	2	31	22.0968	4.5852	.8235
DES4RECG	1	19	10.6842	2.1357	.4900
	2	32	11.1875	1.8741	.3313
PRESSURE	1	19	8.5263	1.7754	.4073
	2	31	8.0968	1.6198	.2909

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOATTI	Equal variances assumed	4.897	.032	.842	47	.404	1.4561	1.7287	-2.0215	4.9338
	Equal variances not assumed			.779	29.264	.442	1.4561	1.8685	-2.3639	5.2762
ANXIETY	Equal variances assumed	.220	.641	1.519	49	.135	1.8618	1.2254	-.6007	4.3244
	Equal variances not assumed			1.474	34.440	.150	1.8618	1.2635	-.7046	4.4283
CONFIDEN	Equal variances assumed	1.770	.190	-.169	48	.867	-.2020	1.1987	-2.6122	2.2082
	Equal variances not assumed			-.184	47.166	.855	-.2020	1.0999	-2.4145	2.0104
DES4RECG	Equal variances assumed	.177	.676	-.880	49	.383	-.5033	.5718	-1.6523	.6457
	Equal variances not assumed			-.851	34.084	.401	-.5033	.5915	-1.7052	.6986
PRESSURE	Equal variances assumed	.160	.691	.878	48	.385	.4295	.4894	-.5545	1.4136
	Equal variances not assumed			.858	35.506	.397	.4295	.5005	-.5861	1.4452

Appendix O: Correlations among TP performance and attitudes factors for all student teachers

Correlations

		TPRESULT	PCK	SCK	TOATTI	ANXIETY	CONFIDEN	DES4RECG	PRESSURE
TPRESULT	Pearson Correlation	1.000	.880*	.125	.755*	.697*	.343	.249	.602*
	Sig. (2-tailed)	.	.000	.495	.000	.000	.059	.169	.000
	N	32	32	32	31	32	31	32	32
PCK	Pearson Correlation	.880*	1.000	.023	.645*	.585*	.301	.285	.471*
	Sig. (2-tailed)	.000	.	.900	.000	.000	.100	.114	.007
	N	32	32	32	31	32	31	32	32
SCK	Pearson Correlation	.125	.023	1.000	.092	.251	-.164	-.079	.170
	Sig. (2-tailed)	.495	.900	.	.623	.166	.379	.669	.352
	N	32	32	32	31	32	31	32	32
TOATTI	Pearson Correlation	.755*	.645*	.092	1.000	.854*	.538*	.478*	.773*
	Sig. (2-tailed)	.000	.000	.623	.	.000	.002	.007	.000
	N	31	31	31	31	31	31	31	31
ANXIETY	Pearson Correlation	.697*	.585*	.251	.854*	1.000	.066	.207	.743*
	Sig. (2-tailed)	.000	.000	.166	.000	.	.725	.255	.000
	N	32	32	32	31	32	31	32	32
CONFIDEN	Pearson Correlation	.343	.301	-.164	.538*	.066	1.000	.461*	.202
	Sig. (2-tailed)	.059	.100	.379	.002	.725	.	.009	.275
	N	31	31	31	31	31	31	31	31
DES4RECG	Pearson Correlation	.249	.285	-.079	.478*	.207	.461*	1.000	-.043
	Sig. (2-tailed)	.169	.114	.669	.007	.255	.009	.	.816
	N	32	32	32	31	32	31	32	32
PRESSURE	Pearson Correlation	.602*	.471*	.170	.773*	.743*	.202	-.043	1.000
	Sig. (2-tailed)	.000	.007	.352	.000	.000	.275	.816	.
	N	32	32	32	31	32	31	32	32

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix P: Correlations among TP performance and attitudes factors for BEd student teachers

Correlations

		SCK	PCK	TPRESULT	ANXIETY	CONFIDEN	DES4RECG	PRESSURE	TOATTI
SCK	Pearson Correlation	1.000	.083	.236	.301	.177	.000	.239	.149
	Sig. (2-tailed)	.	.759	.380	.258	.512	1.000	.372	.596
	N	16	16	16	16	16	16	16	15
PCK	Pearson Correlation	.083	1.000	.864*	.678*	.315	.313	.532*	.652*
	Sig. (2-tailed)	.759	.	.000	.004	.235	.238	.034	.008
	N	16	16	16	16	16	16	16	15
TPRESULT	Pearson Correlation	.236	.864*	1.000	.828*	.362	.337	.727*	.792*
	Sig. (2-tailed)	.380	.000	.	.000	.169	.201	.001	.000
	N	16	16	16	16	16	16	16	15
ANXIETY	Pearson Correlation	.301	.678*	.828*	1.000	.602*	.635*	.664*	.963*
	Sig. (2-tailed)	.258	.004	.000	.	.014	.008	.005	.000
	N	16	16	16	16	16	16	16	15
CONFIDEN	Pearson Correlation	.177	.315	.362	.602*	1.000	.428	.488	.740*
	Sig. (2-tailed)	.512	.235	.169	.014	.	.098	.055	.002
	N	16	16	16	16	16	16	16	15
DES4RECG	Pearson Correlation	.000	.313	.337	.635*	.428	1.000	-.050	.638*
	Sig. (2-tailed)	1.000	.238	.201	.008	.098	.	.854	.011
	N	16	16	16	16	16	16	16	15
PRESSURE	Pearson Correlation	.239	.532*	.727*	.664*	.488	-.050	1.000	.717*
	Sig. (2-tailed)	.372	.034	.001	.005	.055	.854	.	.003
	N	16	16	16	16	16	16	16	15
TOATTI	Pearson Correlation	.149	.652*	.792*	.963*	.740*	.638*	.717*	1.000
	Sig. (2-tailed)	.596	.008	.000	.000	.002	.011	.003	.
	N	15	15	15	15	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix Q: Correlations between achievements and attitudes for CE students

Correlations

		SCK	PCK	TPRESULT	TOATTITU	ANXIETY	CONFIDEN	DES4RECG	PRESSURE
SCK	Pearson Correlation	1.000	-.054	.000	.034	.224	-.262	-.438	.081
	Sig. (2-tailed)	.	.843	1.000	.902	.404	.327	.090	.766
	N	16	16	16	16	16	16	16	16
PCK	Pearson Correlation	-.054	1.000	.924*	.640*	.614*	.230	.150	.443
	Sig. (2-tailed)	.843	.	.000	.008	.011	.392	.580	.086
	N	16	16	16	16	16	16	16	16
TPRESULT	Pearson Correlation	.000	.924*	1.000	.709*	.625*	.333	.234	.460
	Sig. (2-tailed)	1.000	.000	.	.002	.010	.208	.383	.073
	N	16	16	16	16	16	16	16	16
TOATTITU	Pearson Correlation	.034	.640*	.709*	1.000	.854*	.396	.349	.793*
	Sig. (2-tailed)	.902	.008	.002	.	.000	.128	.185	.000
	N	16	16	16	16	16	16	16	16
ANXIETY	Pearson Correlation	.224	.614*	.625*	.854*	1.000	-.114	-.041	.891*
	Sig. (2-tailed)	.404	.011	.010	.000	.	.674	.880	.000
	N	16	16	16	16	16	16	16	16
CONFIDEN	Pearson Correlation	-.262	.230	.333	.396	-.114	1.000	.678*	-.157
	Sig. (2-tailed)	.327	.392	.208	.128	.674	.	.004	.562
	N	16	16	16	16	16	16	16	16
DES4RECG	Pearson Correlation	-.438	.150	.234	.349	-.041	.678*	1.000	-.043
	Sig. (2-tailed)	.090	.580	.383	.185	.880	.004	.	.874
	N	16	16	16	16	16	16	16	16
PRESSURE	Pearson Correlation	.081	.443	.460	.793*	.891*	-.157	-.043	1.000
	Sig. (2-tailed)	.766	.086	.073	.000	.000	.562	.874	.
	N	16	16	16	16	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix R: Intercorrelations among the attitude measures for all students, CE and BEd student

Correlations

		ANXIETY	CONFIDEN	DES4RECG	PRESSURE
ANXIETY	Pearson Correlation	1.000	.066	.207	.743*
	Sig. (2-tailed)	.	.725	.255	.000
	N	32	31	32	32
CONFIDEN	Pearson Correlation	.066	1.000	.461*	.202
	Sig. (2-tailed)	.725	.	.009	.275
	N	31	31	31	31
DES4RECG	Pearson Correlation	.207	.461*	1.000	-.043
	Sig. (2-tailed)	.255	.009	.	.816
	N	32	31	32	32
PRESSURE	Pearson Correlation	.743*	.202	-.043	1.000
	Sig. (2-tailed)	.000	.275	.816	.
	N	32	31	32	32

**. Correlation is significant at the 0.01 level (2-tailed).

Relationships among the attitude measures of all student teachers

Correlations

		ANXIETY	CONFIDEN	DES4RECG	PRESSURE
ANXIETY	Pearson Correlation	1.000	-.114	-.041	.891*
	Sig. (2-tailed)	.	.674	.880	.000
	N	16	16	16	16
CONFIDEN	Pearson Correlation	-.114	1.000	.678*	-.157
	Sig. (2-tailed)	.674	.	.004	.562
	N	16	16	16	16
DES4RECG	Pearson Correlation	-.041	.678*	1.000	-.043
	Sig. (2-tailed)	.880	.004	.	.874
	N	16	16	16	16
PRESSURE	Pearson Correlation	.891*	-.157	-.043	1.000
	Sig. (2-tailed)	.000	.562	.874	.
	N	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

Relationships among the attitude measures of CE student teachers

Correlations

		ANXIETY	CONFIDEN	DES4RECG	PRESSURE
ANXIETY	Pearson Correlation	1.000	.428	.488	.664*
	Sig. (2-tailed)	.	.098	.055	.005
	N	16	16	16	16
CONFIDEN	Pearson Correlation	.428	1.000	.635*	-.157
	Sig. (2-tailed)	.098	.	.008	.562
	N	16	16	16	16
DES4RECG	Pearson Correlation	.488	.635*	1.000	-.050
	Sig. (2-tailed)	.055	.008	.	.854
	N	16	16	16	16
PRESSURE	Pearson Correlation	.664*	-.157	-.050	1.000
	Sig. (2-tailed)	.005	.562	.854	.
	N	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations among attitude measures for BEd students

Appendix S: T-Test Result Comparing Pre-TP and Post-TP Attitudes for all BEd and CE Student Teachers

i) T-Test result comparing Pre and Post Attitude for all student teachers

Group Statistics

	VAR00001	N	Mean	Std. Deviation	Std. Error Mean
TOATTI	1	97	68.0309	6.1635	.6258
	2	31	72.3548	10.2162	1.8349
ANXIETY	1	103	23.7184	4.4290	.4364
	2	32	24.2188	6.1943	1.0950
CONFIDEN	1	102	24.9118	4.1173	.4077
	2	31	27.8065	3.5723	.6416
DES4REG	1	104	11.0288	1.8719	.1836
	2	32	10.9375	2.4222	.4282
PRESSURE	1	100	8.3400	1.5777	.1578
	2	32	9.0938	2.4278	.4292

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOATTI	Equal variances assumed	20.784	.000	-2.857	126	.005	-4.3239	1.5132	-7.3185	-1.3293
	Equal variances not assumed			-2.230	37.228	.032	-4.3239	1.9387	-8.2512	-.3966
ANXIETY	Equal variances assumed	9.267	.003	-.505	133	.615	-.5003	.9912	-2.4609	1.4603
	Equal variances not assumed			-.424	41.313	.673	-.5003	1.1788	-2.8803	1.8797
CONFIDEN	Equal variances assumed	2.560	.112	-3.529	131	.001	-2.8947	.8202	-4.5172	-1.2722
	Equal variances not assumed			-3.808	56.385	.000	-2.8947	.7602	-4.4173	-1.3721
DES4REG	Equal variances assumed	.074	.785	.225	134	.823	9.135E-02	.4069	-.7133	.8960
	Equal variances not assumed			.196	43.003	.845	9.135E-02	.4659	-.8482	1.0309
PRESSURE	Equal variances assumed	11.637	.001	-2.043	130	.043	-.7538	.3690	-1.4838	-2.37E-02
	Equal variances not assumed			-1.648	39.718	.107	-.7538	.4573	-1.6781	.1706

ii) T-Test result comparing Pre and Post Attitude for BEd student teachers

Group Statistics

	VAR00001	N	Mean	Std. Deviation	Std. Error Mean
TOATTI	1	47	69.2553	6.3433	.9253
	2	15	72.0000	11.1355	2.8752
ANXIETY	1	51	24.9412	4.3008	.6022
	2	16	25.6250	5.5842	1.3961
CONFIDEN	1	50	24.7000	3.8346	.5423
	2	15	26.8000	2.9326	.7572
DES4REG	1	52	11.0000	1.7601	.2441
	2	16	9.7500	2.8868	.7217
PRESSURE	1	50	8.4200	1.4859	.2101
	2	16	9.1875	2.4281	.6070

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOATTI	Equal variances assumed	14.227	.000	-1.197	60	.236	-2.7447	2.2929	-7.3312	1.8418
	Equal variances not assumed			-.909	16.994	.376	-2.7447	3.0204	-9.1173	3.6280
ANXIETY	Equal variances assumed	5.030	.028	-.516	65	.608	-.6838	1.3263	-3.3326	1.9650
	Equal variances not assumed			-.450	20.885	.658	-.6838	1.5204	-3.8467	2.4791
CONFIDEN	Equal variances assumed	2.902	.093	-1.953	63	.055	-2.1000	1.0755	-4.2493	4.930E-02
	Equal variances not assumed			-2.255	29.805	.032	-2.1000	.9314	-4.0026	-.1974
DES4REG	Equal variances assumed	3.301	.074	2.112	66	.039	1.2500	.5920	6.805E-02	2.4319
	Equal variances not assumed			1.641	18.557	.118	1.2500	.7618	-.3471	2.8471
PRESSURE	Equal variances assumed	10.262	.002	-1.525	64	.132	-.7675	.5034	-1.7732	.2382
	Equal variances not assumed			-1.195	18.728	.247	-.7675	.6424	-2.1133	.5783

iii) T-Test result comparing Pre and Post Attitude for CE student teachers

Group Statistics

	VAR00001	N	Mean	Std. Deviation	Std. Error Mean
TOATTI	1	50	66.8800	5.8192	.8230
	2	16	72.6875	9.6313	2.4078
ANXIETY	1	52	22.5192	4.2587	.5906
	2	16	22.8125	6.6254	1.6563
CONFIDEN	1	52	25.1154	4.3999	.6102
	2	16	28.7500	3.9412	.9853
DES4REG	1	52	11.0577	1.9942	.2766
	2	16	12.1250	.8851	.2213
PRESSURE	1	50	8.2600	1.6759	.2370
	2	16	9.0000	2.5033	.6258

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TOATTI	Equal variances assumed	8.582	.005	-2.929	64	.005	-5.8075	1.9831	-9.7691	-1.8459
	Equal variances not assumed			-2.282	18.631	.034	-5.8075	2.5446	-11.1405	-.4745
ANXIETY	Equal variances assumed	5.250	.025	-.209	66	.835	-.2933	1.4003	-3.0890	2.5025
	Equal variances not assumed			-.167	18.966	.869	-.2933	1.7585	-3.9743	3.3877
CONFIDEN	Equal variances assumed	2.004	.162	-2.957	66	.004	-3.6346	1.2293	-6.0890	-1.1803
	Equal variances not assumed			-3.136	27.520	.004	-3.6346	1.1589	-6.0104	-1.2588
DES4REG	Equal variances assumed	9.578	.003	-2.071	66	.042	-1.0673	.5155	-2.0965	-3.81E-02
	Equal variances not assumed			-3.014	57.325	.004	-1.0673	.3542	-1.7764	-.3582
PRESSURE	Equal variances assumed	2.536	.116	-1.354	64	.180	-.7400	.5464	-1.8316	.3516
	Equal variances not assumed			-1.106	19.488	.282	-.7400	.6692	-2.1383	.6583