Students' attitudes towards

first-year university mathematics

A comparison between Australian and Asian born students

SHIHUA YANG B.Sc. (Xuzhou), B. Ed. (East China)

School of Education

Victoria University of Technology

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Declaration of originality

This thesis contains no material which has been accepted for any other degree in any university. To the best of my knowledge and belief, this thesis contains no material previously published or written by any other person, except where due reference is given in the text.

Signature:

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Contents

List of Tables

List of Figures

Appendices

Abstract

To improve the quality of mathematics teaching and learning for students born in different countries, it is important to get responses from a student perspective. This study has analysed the attitudinal differences to the learning of mathematics through comparing Australian-born and Asian-born students' attitudes towards their year 12 and university mathematics learning. This has resulted in different responses from students who are studying in different faculties in Victoria University of Technology and who were born in Australia, Europe, or Asia.

The study has explored Australian and Asian born students' attitudes toward year 12 and university mathematics learning and relationships to their cultural effects and educational effects. The findings indicate that attitudinal differences toward mathematics learning are found between students who studied year 12 in Australia and those who studied in Asia. These differences occurred in items on the questionnaire that explored the genesis of students' attitudes into three categories: cognitive category, affective category and learned category. Findings suggest that students' attitudes towards mathematics learning can be influenced through their cultural background and the education system in which they completed their final year high school education. Cultural influences and educational effects appear to mainly affect students' attitudes to mathematical learning ability, learning enthusiasm and learning endeavour. The implications are that it is valuable to identify the way culture affects the learning milieu. It is important to create opportunities for employing and sharing their learning methods and strategies obtained from both high school and university learning. Peer influences, parental interests and students' expectation for future career are essential parts of encouraging and supporting students' learning. Probing and analysing unsuccessful learning experiences could provide very useful information for developing successful learning methods and maintaining positive learning attitudes.

Chapter 1 Introduction

1.1 The research problem

Higher education has, over the past decade, undergone significant changes, which have had far-reaching ramifications for university teaching and the success rate for graduating students. In Australia particularly, the opening up of higher education to hitherto under-represented groups (Dawkins 1988; National Board of Employment, Education and Training 1990) and the change in student population which has resulted from large scale immigration, has thrown new strains and tensions on teaching in universities, particularly at the first year level (McInnes & James 1995). In some universities, these changes have been acutely felt in the sciences, where standards and pass rates in first year mathematics have progressively fallen to very low levels (McAndrew, Murray, Armour & Thomas 1994; Barling, Johnston&Jones 1989). Notwithstanding the introduction of supplementary instruction or mathematics bridging and support courses, pass rates continue to decline, a factor of concern to both staff and education authorities (Barling, Johnston&Jones 1989).

1.2 The role of attitudes in mathematics learning

Recent research has suggested that students' attitudes toward mathematics may be a significant contributing factor to their lack of performance at the higher education level (Leder 1992). Indeed, the Australian Education Council (1990) has stated that the improvement in students' attitudes toward mathematics is an educational issue of central importance. Unfortunately, the term 'attitude' is difficult to define precisely, and its many variations in meaning (for example Campbell 1963; Greenwald 1968; Fishbein & Ajzen 1975) have hampered research in this area. This has meant that there is wide scope for further investigations, particularly at local levels, into the question of students' participation and achievement in mathematics and their attitudes toward mathematics.

1.3 The role of culture in attitude formation

Even though the concept of attitude lacks precise definition, it has been agreed that there is a number of contributing factors to the development of attitudes in students. In particular, it would appear that one of the contributing factors is that mathematics is a 'cultural phenomenon' (Swetz 1978; Campbell & Connolly 1984; Leder 1985, 1987; Bishop 1988; Davis 1990; Caplan, Choy & Whitemore 1992; Thomas 1992; Huang&Waxman 1993). Students, both from non-traditional backgrounds and from overseas cultures, value mathematics differently and this may affect their attitude to mathematics. With the considerable proportion of overseas born and educated students in science-based courses in Victorian Universities, this issue has particular and pressing importance to mathematics educators.

1.4 The need for comparative cultural research into attitude formation

It appears that there are two areas of research, which are currently not sufficiently advanced to provide practical support for mathematics teaching and learning at first-year university level. Firstly, Australia is a country that has accepted migrants from many diverse cultural backgrounds, which suggests that Australia could be an excellent laboratory for comparative cultural studies. Research into cultural comparisons in different study areas provides very useful information for practising teachers faced with multicultural classes (Bishop 1988; Caplan, Choy & Whitemore 1992; Bishop 1994) and the implications of this work are that it will enrich multicultural development, teaching and learning quality in Australia. However, comparative research is very rarely employed in science education in comparison with the area of languages and the area of arts (Thomas 1992). Currently, therefore, there is insufficient evidence comparing cross-cultural influences on students' attitudes towards mathematics.

Secondly, mathematics courses are an essential part of science and technology education at both secondary and tertiary levels. Recently, with larger numbers of non-traditional students gaining access to the university system, there has been increasing and changing demand for the provision of first year mathematics education in Australia. However, there is a considerable lack of educational research focusing on the concomitant student attitude changes, which have affected the transition process between year 12 and tertiary education. In particular, the change with respect to teaching and learning issues between Victoria Certificate of Education (VCE) mathematics and tertiary level mathematics is not well understood.

1.5 The target sample

Consequently, this project focused on cross-cultural issues in attitude formation for students involved in first-year university mathematics at Victoria University of Technology (VUT). This project therefore is a comparative cultural study focusing on students' attitudes towards mathematics, and is specifically concerned with the effects of cross-cultural influences. The three target groups used for this project were Australian first-year university students, enrolled at the VUT, who studied their senior secondary school mathematics in either Australia, Europe or Asian countries.

1.6 The anticipated outcomes of this study

By examining the cross-cultural effects on attitude formation towards mathematics learning, it was anticipated that information would be available for lecturing staff in order that they could design more inclusive curricula, introduce culturally sensitive teaching strategies and provide an appropriate learning milieu to enhance students' attitudes toward first year mathematics. This, in turn, should contribute to reversing the trend in declining pass rates in mathematics subjects at some universities.

Chapter 2 Literature Review

2.1 Introduction

The literature review will focus on work which contributes to an understanding of cross-cultural influences on first-year university students' attitudes towards mathematics and mathematics learning. Its purpose is to explore influences on first year university students' attitudes which arise from such factors as family background, school learning milieu and, in particular, their final year secondary learning experiences. This has implications of considerable importance in regard to students studying tertiary mathematics in Australia generally, but particularly at the VUT, since many of these students were born in Asia and studied year 12 or an equivalent final year of secondary school in Asia.

Two broad educational research areas are considered in this study. The first is comparative research concerning cross-cultural influences to students' attitudes and beliefs, which will include home influences and learning milieu. This comparison will have Australian and Asian born students' attitudes toward mathematics as its focus. In particular, the nature of students' attitudes appears to be affected by the location of their final years of secondary study, and this project will particularly compare differences arising from experiences gained in Australia or Europe, with Asia. The second area is educational research concerning mathematics teaching and learning in mathematics at both final-year secondary and first-year tertiary levels.

Within these two broad research areas, three specific focuses have been identified for special attention. These are (i) students' beliefs about the role of mathematics ability as a determining factor in mathematical learning success, (ii) the role of students' innate enthusiasm for learning mathematics as a necessary factor in success, and (iii) students' beliefs about the importance of learning strategies and persistence in achieving success in mathematics.

2.1.1 Attitudes

The psychologist William James (1978) compellingly illustrated the importance of attitude to human endeavour when he said:

> I have often thought that the best way to define a man's character would be to seek out the particular mental or moral attitude in which, when it came upon him, he felt himself most deeply and intensely active and alive. At such moments there is a voice inside which speaks and says: 'This is the real me!' (p.583).

This central importance of mental and moral attitude seems to be accepted as a prerequisite for success or achievement in many spheres of life, but it is the question of *how these attitudes are fostered* which concerns us here.

For example, Leder (1992) stated it is now widely recognised that understanding the nature of mathematics learning requires exploration of affective (attitudinal) as well as cognitive factors. The Australian Education Council (1990) claimed that:

> An important aim of mathematics education is to develop in students positive attitudes towards mathematics and their own involvement in it, and an appreciation of the nature of mathematical activity. The notion of having a positive attitude towards mathematics encompasses both liking mathematics and feeling good about one's own capacity to deal with situations in which mathematics is involved (p.31).

When reviewing the published research on student attitude to mathematics, Wittrock (1986) and Leder (1992) stated that there has been a significant change of methodology since the 1980s. The earlier research concentrated upon definitions of attitude but did not explore the interaction between student and teacher attitudes and school learning in any depth. Leder (1992) also noted that the influential *Handbook of Research on Mathematics Teaching and Learning* (Grouws 1992) devoted considerable space to the impact on mathematics learning of affective factors, including student and teacher beliefs and attitudes.

Many different instruments have been used to measure students' attitudes to learning in general, and this is also true for measurement of students' attitudes to mathematics. Grouws (1992) pointed out that recent research focusing on students' attitudes towards mathematics, and its effective (learning skills) and affective (emotional) factors, has become increasingly important in educational research areas. Also, Leder (1992) noted that attitudinal research had become a concern in different countries. Leder observed:

> The similarities of problems faced by teachers in different countries and in different educational settings were particularly striking. Maximising opportunities for fruitful dialogue between researchers and practitioners, and between those in different countries struggling with similar concerns, were seen as high priorities. This special issue of the *Mathematics Education Research Journal* is one step along this path (p.5).

2.1.2 Definition of Attitude

The term 'attitude' has many different definitions according to different analytical perspectives. Campbell (1963), Greenwald (1968) and Fishbein and Ajzen (1975) concluded that these different perspectives have resulted in a diversity of definitions. McGuire (1969) and Elizur (1970) stated that it is hardly surprising that few investigators agree on an explicit definition of attitude. Furthermore, Fishbein and Ajzen (1975) indicated that the concept of attitude is characterised by an embarrassing degree of ambiguity and confusion. For instance, some definitions describe attitude as:

- ...involving what people think about, feel about, and how they would like to behave towards an attitude object. Behaviour is not only determined by what people would like to do but also by what they think they should do, that is, social norms, but what they have usually done, that is habits, and the expected consequences of behaviour. (Triandis 1971, p.14)

- ...a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object (Fishbein & Ajzen 1975, p.6)
- ...being closely linked to beliefs, emotions, and motivation to engage in the subject (Leder 1992, p.1)
- ...a relatively enduring organisation of beliefs around an object or situation predisposing one to respond in some preferential manner (Rokeach 1968, p.112)
- ...learned, emotionally toned predispositions to react in a consistent way toward persons, objects, and ideas (Klausmeier 1985, p.375)
- ...attitudes have both an affective component (feeling, emotional) and cognitive component (informational). Affective component of an attitude refers to the emotions one associates with an object, person, event, or idea. Cognitive component corresponds to person's knowledge about an entity (Klausmeier 1985, p.376)
- ...attitudes are learned through different ways, including by observing and imitating, by receiving reinforcement, by gaining information (Lindzey 1978; Klausmeier 1985, p.382;)
- a"... way of thinking, acting, or feeling" that affects development (Thorndike & Barnhart 1968; Taylor 1992, p.11)
- ... with this definition affect becomes only one part of an attitude. There are also cognitive and behavioural components (Taylor 1992, p.11)

The preferred concepts of attitude for this study are those which describe attitude as having three components: affective, cognitive and behavioural. Those definitions are discussed by Thorndike and Barnhart (1968), Lindzey (1978), Klausmeier (1985) and Taylor (1992). Therefore, this study uses a definition of attitudes that states: attitudes are formed by three components: affective, cognitive and behavioural. The affective component of an attitude refers to the emotions and feelings one associates with an object, person, event, or idea. The cognitive component corresponds to a person's knowledge about an entity. The behavioural component relates to a person's reaction to learned information through different ways, including by observing and imitating, by receiving reinforcement, and by gaining information.

2.2 Cross-cultural affects on attitudes

In recent years, there has been considerable debate regarding the concept of 'mathematics as culture' or 'mathematics in culture'. Davis (1990) suggested that 'Mathematics is itself a cultural phenomenon, and the international culture of mathematics runs across and through national and local cultures' (p.12). Referring to the links between mathematics culture and students' social culture, he commented that:

> Everyday mathematics is tied to a particular culture other than an international mathematical culture. Linking people's everyday mathematics to a broad mathematical culture ought to be consistent with respect for individuals' own mathematics, as well as respect for broader mathematical culture by individuals (p.12).

It is this debate about mathematics and culture that suggests that mathematics learning may be influenced through students' cultural backgrounds, and those cultural differences might affect students' attitudes and values regarding mathematics learning.

Comparative research by Campbell and Connolly (1984) indicated that Asian students' attitudes towards mathematics are different to those of European students. They reason that Asian students tend to retain the attitudes and values of their former countries and are greatly influenced by peers and others to achieve. Huang (1993) has also compared students' cross-cultural differences affecting their motivation and perception towards learning environments. He stated that Asian-American students demonstrate great pride in their class work, a stronger desire to succeed, and higher expectations to do well in mathematics. In addition, he claimed that these students enjoyed mathematics classes and assignments more than Anglo-American students, and participated readily in class activities.

Referring to the importance of understanding the process of transition to new cultural environments and a new learning milieu, Caplan, Choy and Whitemore (1992) described the learning experiences of refugees to the United States in the late 1970s and the early 1980s. The refugees included many young people who had escaped from Southeast Asian countries such as Vietnam, Laos and Cambodia. Although they had suffered personal disruption and hardship, and had little knowledge of English, these refugee children quickly adapted to their new schools, and began to excel in mathematics in particular.

Because they were newcomers in a strange land, Caplan, Choy and Whitemore (1992) suggest that it would be reasonable to expect that the success of these children is due, at least in part, to their cultural background. They suggest that the values and traditions permeating the lives of Southeast Asian students appears to 'guide them' in the new culture of the United States. Caplan, Choy and Whitemore (1992) believe that it is possible to identify 'culturally compatible values, behaviours and strategies for success that might enhance scholastic achievement' (p.18). They suggested that research should be carried out to clarify the cultural differences and values which might enhance students' learning success.

Swetz (1978) and Bishop (1988) have suggested another important perspective, which is to recognise mathematics education as being a social process. Swetz (1978) studied mathematics education in the seven socialist societies (USSR, German Democratic Republic, People's Republic of China, Yugoslavia, Sweden, Hungary, and Tanzania). He observed how, in these societies, societal goals and aspirations shaped mathematics education. Bishop (1988), in a similar study, divided aspects of mathematics education into five levels: cultural, societal, institutional, pedagogical and individual. He considered the research by Swetz (1978) to be at the societal level. He argued that:

> Even though the subject 'mathematics' may have the same label in different schools there is no necessary reason why school mathematics should be the same in a school in one society as that in a school in another society. There will be similarities, of course, as in Swetz' book, but there will also be differences (p.4).

Whereas Bishop's 1988 study indicated that there are both similarities and differences within different countries it did not, however, provide specific items and details about attitudinal differences and similarities.

Bishop (1988, 1994) has further argued that mathematics education has a significant social dimension, and that mathematics is a form of cultural knowledge. The 'social dimension' of mathematics education operates at different levels, all of which are relevant in considering how and what, for example, indigenous peoples learn when studying mathematics. It also follows from this social view of education that individuals are influenced in their mathematical education by those around them who are acting at these different levels.

In the context of this thesis, what is most important about this social perspective on learning in mathematics education, is that *at each level there are particular sources of cultural conflict.* Hence an underlying principle is the status of mathematics as a form of cultural knowledge and Bishop (1988) went on to suggest ways in which cultural conflicts can be solved through cross-cultural understanding.

It has been observed that students' attitudes and values could affect each other. As Thomas (1992) suggested, 'If the cultural roots of mathematics are accepted, then it follows that there are certain values associated with the teaching and learning of mathematics' (p.4). Cross-cultural comparisons regarding students' values could provide useful information for positively reinforcing and developing students' attitudes towards mathematics, as well as providing useful information for improving mathematics teaching and learning methods.

2.3 Mathematics and the transition process between final year high school and first-year of university mathematics learning

In both Australia and Asia, the 'transition problem' between final year of schooling and first-year university mathematics learning has become a common topic of concern. Some students, who had good results in secondary school, have shown considerable difficulty in making the transition to university mathematics. For example, in Australia Barling (1989) observed that:

> For many years Swinburne, like other Institutes of Technology, has admitted students to first year studies in Applied Science and

> Engineering without the normal prerequisites in mathematics. Some of these have been admitted under 'special entry' schemes whereby the state government has provided additional funding to enable so-called 'disadvantaged' students to be given additional supplementary instruction in mathematics during their first year studies (p.384).

Tracing this transition problem, Barling (1989) reasoned that it was caused by government policy to increase the number of graduates in science and engineering and other technology-related courses. However, there were not enough adequately qualified mathematics or science students completing secondary school, and he suggested that:

> While places have been made available to such students, particularly in institutes of technology, experience has shown that many of these students fail to cope. More often than not it is a lack of adequate mathematical skills that is the major barrier to success and, while additional assistance is provided by teaching staff during the course, this has not been sufficient to overcome the problem. As a result, many of these students fail to make the grade at the end of first year or merely scrape through and remain 'at risk' for the remainder of their course (p.384).

In a more recent Australian study, McAndrew et al.(1994) indicated that:

> Standards and pass rates in first year mathematics have progressively fallen in recent years. The pass rate in first semester first year Engineering Mathematics (SMA1211) in 1993 was 35%. This is about half of what it had been five years ago. 1993 was the first time that we had enrolled students who had completed the current Victoria Certificate of Education (VCE) program (p.12).

He further noted that although the declining pass rates and drop in standards for first year mathematics subjects had been blamed on current VCE practices, this cannot be the only cause. Many of the students involved in this analysis enrolled as direct entries; that is they did not come to the course after completing the VCE.

McAndrew found that there were two causes of concern among higher education staff. These were the current students' lack of (i) basic skills in arithmetic, elementary algebra, understanding graphs, and (ii) geometric knowledge and understanding. In a similar vein Gates (1994), referring to students who were studying first year university mathematics at University of Tasmania, found that lack of prior learning, including previous learning skills and knowledge, affects the depth and clarity of university students' understanding of mathematics.

In Asia, Pongboriboon (1992) argued that there were very many first year students at Khon Kaen University (KKU) in Thailand experiencing difficulties in coping with their mathematics courses, and noted that certain factors appeared to directly relate to difficulties associated with students' transition from senior secondary school to university mathematics.

Focusing on the 'transition problem' at KKU, Pongboriboon (1992) suggested that studies should be undertaken to assess the varying extents to which school teachers, university lecturers, and first-year university students differ in their perceptions of how school and university courses should be related. Pongboriboon (1993) extended this study in an attempt to clarify which factors most strongly affect performance in the first year mathematics program at KKU. In a survey of the first year mathematics course during the 1990-1991 academic year, students from four KKU faculty groups (Medicine and Nursing, Agriculture, Science and Education, and Engineering) were surveyed. Four factors were indicated as the significant predictor variables most strongly affecting performance in first year mathematics for most faculty groups. These factors were (i) secondary school mathematics achievement, (ii) self esteem, (iii) study habits in mathematics, and (iv) faculty of study field. Other minor predictor variables (depending on the faculty group) were socio-economic status, mathematics language competencies, and mathematics confidence.

In the same study, Pongboriboon also found that scores on the Direct Entry Examination Mathematics Test (administered by KKU) and the School Mathematics Achievement test (developed and administered by Pongboribooon) had stronger correlations with first year KKU mathematics performance than did scores from the National Entry Examination Mathematics tests (administered by the Thai Ministry of University Affairs). This study further investigated why many first year students experienced difficulties in coping with their mathematics courses. Interviews with a group of senior secondary mathematics teachers, university mathematics lecturers, and first year mathematics students, showed that the major sources of difficulty were associated with (i) students' mathematical abilities, (ii) the curriculum content, (iii) course organisation, (iv) students' study habits, (v) instructional styles, and (v) assessment procedures.

Similar studies in the United States, (for example, Lehmann 1987; Thorndike 1991) have indicate both similarities and differences between students' attitudes and mathematics learning at year 12 and first year university. The research indicated that there are correlations between previous attitudes (at year 12) and demonstrated attitudes (at First-year University). Thorndike (1991) put forward the view that attitudes toward mathematics are predictive of both final mathematics course grades and an intention to continue to participate in mathematics courses once enrolment becomes optional. He also found that students in more accelerated mathematics 'tracks' had more positive attitudes. By contrast, Lehmann (1987) argued that university learning could change students' previous attitudes, stating that students who had taken at least one college course previously had a better attitude towards mathematics than those who were taking their first college mathematics course.

Regarding students' mathematics learning outcomes at final year senior secondary and first year university mathematics, research in the United States also indicated controversy concerning the interaction between previous experiences (at final year secondary) and later learning outcomes (at first-year university). One standpoint, supported by Uguroglu & Walberg (1979), noted that grade level emerged as the only significant student characteristic in achievement and motivation scores, and also that these were more highly correlated in the later grades. In addition, Gross (1988) emphasised that the best way for any student to be successful in mathematics is to have succeeded in mathematics in the past.

In another study, Clarke (1984) argued that age and previous experience as a learner were not shown to interact in any way with interactive or non-interactive formats of instruction. In this study, the test materials (audio and written materials) were designed as text interactive and non-interactive formats. Sixty-five mature aged students at a college of advanced education were tested in terms of achievement, retention and attitude following instruction using the test materials. The results regarding learning outcome, retention and attitude indicated that there were no significant differences between students who were given their preferred choice of learning format and those who were assigned to a predetermined format.

2.4 Mathematics and learning ability

The issue of most concern in this section is the question of how students perceive their own learning abilities in relation to the teaching and learning methods, that is, the affective factors involved in student instruction. Whilst there is little literature dealing directly with students' perception of learning abilities, it seemed appropriate to use the concept of student 'self-concept' as a focus, since the issue of self-concept is related closely to the issue of students' perception of their learning ability.

There are a number of published analyses of student self-concept and its related factors. Generally, student self-concept has been linked with motivation, achievement, effort, teaching and learning style, and home expectations. For example, in research by Ali (1984) self-concept was associated with academic achievement. Working with secondary students, he concluded that there is a positive correlation between academic achievement and self-concept, and that academic performance improves as self concept is developed.

Similarly, Payne (1992) who examined the effects of motivation on secondary students also considered student self-concept. Included in this study were concepts of achievement, motivation, academic self-concept, social self-concept, and emotional self-concept, which were related to affective factors such as classroom learning environment including involvement, affiliation, teacher support, task orientation, order and organisation, and rule clarity. Furthermore, Payne stated that academic self-concept has significant positive effects on mathematics scores.

In an investigation involving learning outcomes and achievements of secondary school students in Hong Kong, Wong (1992) suggested that mathematics achievement and self-concept show high correlation. In a previous study it had been shown that the most important variable influencing mathematics achievement was self-expectation (Wong & Cheng 1991). Both self and parental expectations were the most influential factors on affective variables such as self-concept, mathematics anxiety, attribution of success and failure, and perceived usefulness of mathematics.

A number of studies have been reported which combine relationship between self-confidence and ability in mathematics achievement of primary and secondary school students. Various perspectives have been taken, including psychological, educational and gender, as follows:

- Johnson's (1982) classification of the affective factors influencing attitude toward mathematics and ability was associated with emotional notions of self-assessment such as self-esteem, intrinsic interest in mathematics and self-confidence. Effective factors, by comparison, were the personal situations of the students including family background, extracurricular activities, academic factors, persons influencing selection of high school mathematics courses, mathematics-related activities, attitudes toward mathematics classes and teachers, favourite and least favourite subject, factors and persons influential in selecting occupations, college majors and mathematics courses, mathematics and society, and personal and psychological variables.
- Referring to students' aspirations and abilities, Marjoribanks (1987, 1988, 1991) proposed that there were group personality differences in the variability of children's aspirations associated with ability and school related attitudes. Ability and attitudes have differential linear relations to aspiration for children from the various personality groups.

- Fishbein (1990) suggested that previous mathematics ability might have motivation effects. Students with higher mathematical ability attend classes more often, spend less time doing homework, and work more quickly and accurately than students with low ability.
- According to Gross (1988), once students experience failure or fall behind grade levels, it becomes more difficult for them to catch up later.
- Baker (1989) studied role-specific self-concept related to ability and career choice. He described males as a group with a more positive science role-specific self-concept than females. Males expect to take more higher-level mathematics courses than females, while females prefer science careers and expected to take the higher-level science courses. He also suggested that logical ability related to a science career preference for both males and females.

These studies indicate that how students perceive their mathematical ability can be affected by a number of factors including previous experience and career choice.

2.5 Mathematics and Learning Enthusiasm

The question of how students feel about mathematics, which relates to where their encouragement to pursue mathematics study came from, seems to be critical to the development of learning enthusiasm. There is also the question of what students perceive the value of mathematics to be. The answers may differ according to grade levels, different family backgrounds, and different learning environments.

An interesting comparative study conducted by Feather (1986), compared the cultural psychology and cultural values of Australian and Chinese students. Involved in this study were one hundred and forty Australian students at Flinders University (Australia), and sixty-eight Chinese students at Shanxi Teachers University in Xi'an (China). The Australian students ranked the following values as significantly higher in importance compared with the Chinese students: an exciting life, a world at peace, family security, happiness, inner harmony, being cheerful, being forgiving, being helpful, being honest, being loving, and being responsible. By comparison, the Chinese students assigned significantly higher importance to: a world of beauty, national security, pleasure, social recognition, wisdom, being ambitious, being capable, being courageous, being imaginative, being intellectual, being logical, and being self controlled.

Wither (1987), working with Australian students, investigated two broad questions related to mathematics enjoyment and the value of mathematics. These were (i) how do attitudes to mathematics relate to mathematics achievement, and (ii) what influence do motivation to achieve and mathematics anxiety have on mathematics achievement? The results obtained indicated that with respect to mathematics attitude the two dimensions that emerged were enjoyment doing mathematics and an appreciation of the value of mathematics. In the case of motivation and anxiety, there were three dimensions that appeared to be important in achieving success in mathematics. These were self-drive, responsibility and perseverance.

Many researchers have also considered how 'family influences' affect students' psychological approach to their study patterns in mathematics. Cheng (1991) compared family influences on students' affective and cultural values by examining the relationship between acceptance of family values and such factors as the nature of the family values, knowledge of parental values, the student's previous mathematics achievement, and the student's psychological well-being. Participants consisted of over 3,000 American, Chinese, and Japanese children in 5th and 11th grades, and their parents. The results of the study found that American students knew more about, and were in greater agreement with, their parents' values concerning academic achievement than Asian students. In the academic domain, a high percentage of all students were in greater agreement with parents than in the social domain. Cheng found that student knowledge of parental values was positively related to agreement with the students' own values, and student acceptance of parental values was positively related to their psychological well being.

Regarding learning preferences and enjoyment of mathematics subjects, Mullis (1992) studied students' attitudes to course utility. He indicated that students with more positive attitudes about the value of what they are learning generally have higher achievement levels. These positive attitudes were linked to an innate liking of mathematics, or recognition of the utility of mathematics, which supports the earlier work of Iben (1988). Foster (1978) also argued that different factors influence high and low achievers in selecting mathematics as part of their academic program, although enjoyment of mathematics and interests in mathematics were important factors for both groups. Further, Wood and Smith (1993) examined students' attitudes to, and ideas about, mathematics at the beginning of a mathematics or engineering degree at university. They argued that students demonstrated a mature understanding of the links between areas of mathematics and everyday applications of work they had studied at school. The mathematics they had studied so far was widely perceived as useful in the development of personal skills: logical thinking, fostering persistence, patience and discipline.

Harwood (1981) identified other factors in students' attitudes to technical learning of pathology, biology and geoscience in certificate courses at Australian Capital Territory tertiary and further education (TAFE) colleges. His results showed that students' attitudes contained two factors. The first factor was how difficult students found aspects of the course, and the second factor was how relevant students found aspects of the course. With respect to the second factor, it appeared that previous work experience had a significant effect. More detailed analysis showed that positive attitudes are related to the amount of work experience, and not to the type of work experience.

In a comparative study involving Australian, Japanese, and United States students, Iben (1988) investigated the development of abstract mathematical thought and spatial relations of 13- and 14-year-old students who attended public schools. Using regression analysis, Iben found that mathematics confidence and lack of anxiety were closely related for Australian, US and Japanese males, but not for females. The students' perception of the utility of mathematics was also shown to be a significant predictor of their confidence with mathematics for Japanese and Australian Asian-born students. In a similar gender study, Thorndike (1991) reported that both male and female students were interested in mathematically related careers.

Focusing on tertiary students' ideas and concept of mathematics, Crawford, Gordon, Nicolas&Prossor (1993) stated that a high proportion of successful school leavers conceived mathematics as numbers, rules, and formulae that can be applied to solve problems. Furthermore, the majority of students viewed mathematics as a necessary set of rules and procedures to be learned by rote and that these are unrelated to other aspects of their lives. They suggested that a 'more cohesive conception of mathematics and/or a deep approach to studying mathematics is positively and cumulatively associated with achievement at university level' (p.213).

In summary, these studies strongly suggest that evidenced mathematical learning enthusiasm can be related to such factors as cultural psychology and cultural value, mathematical enjoyment and appreciation of the value of mathematics, family influences, recognition of the utility of mathematics and its every day applications, and previous learning outcomes and gender specifics.

2.6 Mathematics and learning endeavour

According to Entwistle (1990):

> The reasons students give for their own success or failure in learning are both a product of past experience and an anticipation of future performance. Students, and teachers, typically explain success or failure in terms of either 'ability' or 'effort'. Ability is thought to be relatively unchangeable, and so teachers urge pupils to 'try hard'. Yet if traditional effort still leads to failure, students are led to see themselves as lacking the necessary ability and so doomed to continue failure (p.666).

Similar research conducted by Wood and Smith (1993) pointed out that both male and female students who were beginning a university mathematics or engineering degree 'attributed their success in mathematics to intrinsic values such as hard work' (p.597). Furthermore, an interesting research result focusing on fifth grade students in elementary school by Lewis (1998) provides useful information for tertiary education research. Lewis (1989) investigated the cross-content consistency of attribution to success in mathematics when they were applied to an expanded range of school subjects. Content areas included reading, writing, mathematics, social studies, and science. The consistency of four attributes (ability, effort, task ease or difficulty, and luck) across the different curriculum areas was examined. Results showed that success attribution to effort and luck was most consistent, while attribution of success to ability and task difficulty appeared to be the less common. Analysis of attribution within content domains showed that attribution to effort was most prominent, particularly for successful students.

Referring to students' cultural backgrounds, different attitudes to ability and effort are reflected in Asian and European students. In a comparative study of achievement, effort and attitude in White American and Asian-American students, Peng (1984) noted that Asian-American students performed well in school. The possible reason was that Asian-American students took more academic courses, spent more time on homework, and were less likely to be absent or late for school. This research did not indicate what the students' attribution styles were, or how the Asian and American students' attribution styles differed.

In a similar study, Ryckman and Mizokawa (1988) conducted a survey of achievement, ability and effort of White and Asian students in Seattle public schools. The data showed that while both groups attributed academic success or failure more to effort than ability, the Asians tended to emphasise effort more than Whites. This pattern was reversed for ability. Students believed that a lack of effort is more a cause of failure in language and arts than in mathematics and science. Furthermore, in researching cultural heritage and historical background, Izawa (1989) argued that any person of any colour or of any national origin with normal intelligence who works extraordinarily hard and strives for excellence would be educationally successful. This is an extreme example of emphasis on much effort in learning. Wong (1992) however, investigated secondary school students in Hong Kong and suggests that the time spent on homework did not exhibit significant co-relation with mathematics achievements.

It is possible to link the above observations with a suggestion by Resnick (1990). She claimed that improvement by effort and help from the social setting are worth considering when determining what roles social interaction may play. She also put forward that there are two functions of the social setting. One is that it provides occasions for modelling effective thinking strategies and, through observing others, students have greater opportunity to become aware of mental processes that might otherwise remain entirely implicit, thereby improving their own thinking. Resnick (1990) claimed another function for practising thinking skills in a highly motivating manner is:

> Through encouragement to try new, more active approaches, and social support even for partially successful efforts, students may come to think of themselves as capable of engaging in independent thinking, of exercising control over their learning processes (p.704).

A comparison by Caplan, Choy and Whitmore (1992) of Indochinese and American counterparts noted that Indochinese families did not trust fate or luck as the determinant of educational outcome, but rather they believed in their potential to master the factors that could influence their destiny. In addition, Caplan, Choy and Whitmore (1992) observed that such students honour mutual, collective obligation to one another and to their relatives:

> The older children, both male and female, help their younger siblings. Indeed, they seem to learn as much from teaching as from being taught. It is reasonable to suppose that a great amount of learning goes on at these times — in terms of skills, habits, attitudes, and expectations as well as the content of a subject. The younger children, in particular, are taught not only subject matter but also how to learn. Such sibling involvement demonstrates how a large family can encourage and enhance academic success. The familial setting appears to make the children feel at home in school and, consequently, perform well there (p.21).

2.7 Conclusion

It would appear from this review of literature that students' attitudes towards mathematics are significantly influenced through their cultural backgrounds. The work discussed in this review indicates that students' attitudes towards mathematics might be reinforced in either positive or negative ways through a variety of affective (behavioural) and affective (learning) factors. However, there is a gap in the evidence which would help clarify the ways in which culture influences students' attitudes, and, in particular, evidence which is obtained *from the perspective of the students themselves*. It appears that an important contribution could be made to the literature if the research involved in this project could gather, describe and collate information from a student perspective regarding cross-cultural influences and other related factors on attitude formation towards mathematics learning.

Chapter 3 Planning and Design

3.1 Introduction

This project focused on the nature of Australian and Asian born students' attitudes towards mathematics. Reported work in the literature suggests that whilst students' attitudes towards mathematics are likely to be shaped through school activities, teaching and learning methods and parental values, cultural background also plays a major role. Consequently, it was thought that this project, which carried out research focusing on students' attitudes to mathematics learning which are related to cross-cultural influences, could provide useful information and significant ideas for improving teaching and learning practice in Australia where the student cultural profile is continually changing. As indicated in the previous Chapter, there appears to be a need for additional work to be done in determining the ways in which culture influences students' attitudes to mathematics, and this project is based on the belief that evidence which is obtained *from the perspective of the students themselves* will be particularly valuable.

To date, comparative research regarding European and Asian born students' attitudes towards mathematics has been carried out in the United States of America (see literature review, Chapter 2). Much of this work describes cross-cultural influences on students' attitudes, and used primary, secondary and tertiary level students as the target populations. In attempting to extend this work, the present study asserts that contemporary Australian education has a distinctive character of multicultural and cross-cultural influences. Comments from Australian higher education mathematics teachers (Barling 1989; Gates 1994; McAndrew, Murray, Armour&Thomas 1994) have indicated the importance of clarifying and identifying the similarities and differences in cross-cultural influences which appear in Australian first-year university mathematics students, and their concerns have significantly helped to shape this study.

3.2 The research question

In the light of the body of comparative research from the United States of America and the concerns of Australian mathematics lecturers, the focus of this project has been upon the relative importance of parental culture and institutional culture in influencing students' attitude toward mathematics. As a result of this interest, the central question that was developed for this work was:

Do the different attitudes which Australian born and Asian born students exhibit towards Australian first-year university mathematics arise from differences in the students' cultural backgrounds, or do they arise from differences in the education system in which they completed their high school education?

From this central question have emerged a number of secondary questions, which have helped in the development of the research instruments and are detailed in the later stages of this chapter (see p.28 Figure 3.1). These secondary questions have been linked to the work identified in the literature review, and have been used to both clarify the context in which the study has been conducted, and to evaluate the importance of other factors which may contribute to observed differences in attitude between the principal groups of students which have been studied.

3.3 The target sample

The specific level of target subjects in this project are Australian first-year university students in a range of science and engineering courses who studied senior high school or year 12 in either (i) Australian or other 'European' countries, or (ii) Asian countries. The definition of the target sample in this way springs from the basic concern of the research question which has been framed to examine whether students' attitudes not only reflect their original cultures, but also whether there is a significant attitudinal change which occurs during the transition from year 12 experiences to first-year mathematics study in an Australian university.

The students in the target sample were studying a first year mathematics subject at Victoria University of Technology as a part of a course in one of the following Departments (i) Computer and Mathematical Sciences, (ii) Applied Physics, (iii) Chemistry and Biology, (iv) Civil and Building Engineering, (v) Mechanical Engineering, (vi) Electrical and Electronic Engineering.

To assist with the investigation of the central research question, the target sample was divided into three groups according to the students' family backgrounds and the circumstances under which they studied year 12 mathematics. The group definitions and the composition of the groups were:

Group G1 consisted of students who were born, and studied year 12, in Australia. There were 177 students in this group.

Group G2 consisted of students who were born in countries other than Australia, but who studied year 12 in Australia. There were 97 students in this second group. These students and their parents were born in the following countries: Italy, Croatia, South Africa, Zimbabwe, Peru, United Kingdom, England, Indonesia, Sri Lanka, New Zealand, Chile, Greece, Yugoslavia, Eritrea, Palestine, Macedonia, Lebanon, Iran, Poland, Philippines, Netherlands, Mauritius, Fiji, East Timor, Cambodia, Vietnam, China, India, Hong Kong, and Taiwan.

Group G3 consisted of students who were born in Asia and studied their final year of secondary schooling in Asia. There were 30 students in this group. These students and their parents came from the following countries: China, Hong Kong, Malaysia, Thailand, and Vietnam.

Australian first-year university mathematics arise from differences in the students' cultural backgrounds, or do they arise from differences in the education system in which they completed their high school education?

Area 1	*Area 2*
Major question: Do the different attitudes which Australian born and Asian born students exhibit towards Australian first-year university mathematics arise from differences in the students' cultural backgrounds ?	**Major question:** Do the different attitudes which Australian born and Asian born students exhibit towards Australian first-year university mathematics arise from differences in the education system in which they completed their high school education?
Focus: Is there an attitudinal difference between students with different *family* cultural backgrounds?	**Focus:** Is there an attitudinal difference between students with different *school* environments in different countries?

Cognitive	*Affective*	*Learning*	*Cognitive*	*Affective*	*Learning*
Question: Do students' attitudes differ in innate ability and demonstrated ability?	**Question:** Do students' attitudes differ in intrinsic drive and extrinsic drive?	**Question:** Do students' attitudes differ in learning effort and outcomes?	**Question:** Do students' attitudes differ in innate ability and demonstrated ability?	**Question:** Do students' attitudes differ in intrinsic drive and extrinsic drive?	**Question:** Do students' attitudes differ in learning effort and outcomes?
Specific items: 2,3,10,11,12,13,14,15, 20,21,28,29,34,35.	**Specific items:** 4,5,6,7,8,9,22,23,24, 25,26,27,30,31, 42,43,44,45,50.	**Specific items:** 16,17,18,19,26,27, 32,33,38,39,40,41, 46,47,48,49.	**Specific items:** 1,2,3,10,11,12,13, 14,15,20,21,28,29, 34,35.	**Specific items:** 4,5,6,7,8,9,22,23,24, 25,26,27,30,31,37, 42,43,44,45,50.	**Specific items:** 16,17,18,19,26,27,32, 33,36,38,39,40,41, 46,47,48,49.

Figure 3.1 Questionnaire design

Project Analysis Scheme

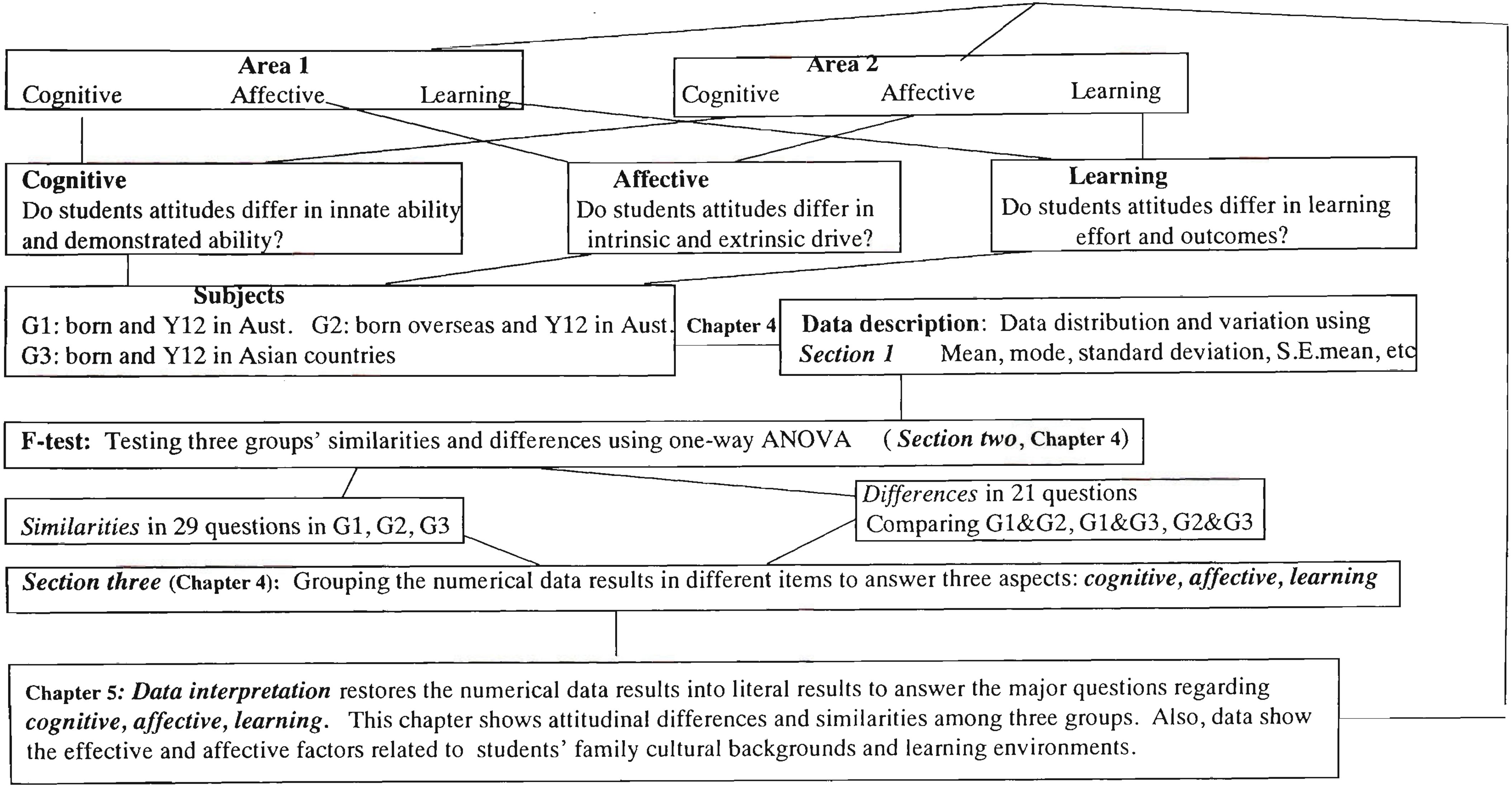


Figure 3.2 Analysis scheme

3.4 Methodology

The six major steps in the conduct of the project were (i) the questionnaire design, (ii) the pilot survey, (iii) revising the questionnaire (iv) main survey and ethics consideration (v) analysis and description of data (vi) interpretation. The design and planning behind each of these steps are discussed in the following sections.

At the outset of planning, the aim of this project was to approach the research question through the groups' average responses to a number of specific response items, rather than to seek responses from individual students. It was therefore appropriate to collect data from a large, representative number of students, and carry out data analysis through quantitative methods.

3.4.1 Questionnaire design

A fifty-item questionnaire, using a six-point Likert scale, was prepared in order to investigate the strength of student perceptions of factors which were indicated by the literature to be important in attitude formation. Collection of data in this form allowed analysis using the commercially available Statistical Package for the Social Sciences (SPSS). As will be indicated in detail in the analysis section, analysis of difference between the three target groups was carried out using the F-test and t-test facilities. Graphical presentation of data was done through spreadsheets using Microsoft Excel.

To guide the questionnaire design, the research was nominally divided into the two major research areas suggested by the research question, and within these areas, three focuses were identified. The two major areas related to (i) cross-cultural influences on attitude formation, and (ii) the transition from year 12 to first year university study. The questions which were designed to probe these areas focused upon three issues related to students' learning ability: (i) the cognitive component (ii) the affective component, and (iii) experience with successful and unsuccessful learning methods. The questionnaire design and analysis scheme are shown in Figures 3.1 and 3.2 (see p.28 , 29).

The first draft of the questionnaire was trialed in a pilot study (see Appendix I).

3.4.2 Revising the questionnaire

- *The necessity of revising the questionnaire*

The pilot survey results clearly identified that the questions posed by this project regarding students' attitudes towards mathematics and cross-cultural influences are real, measurable problems and it is possible to further clarify the students' perspectives on a large scale.

However, the pilot survey indicated that the specific response items were not sufficient in exploring family cultural influences to students' attitudes, especially with regard to parental influences. Therefore, two modifications to the specific response items were carried out as a result of the pilot survey.

In order to strengthen the questionnaire with respect to students' perceptions regarding family and parental influences on student attitudes, seven specific response items were added. This made a total of fifty questions in the revised questionnaire. The advantage of the revised questionnaire is that it kept the original content and structure of the pilot questionnaire, with only a small increase in the number of specific response items.

The revised questionnaire is attached in Appendix II.

- *The revised questionnaire*:

The literature concerning the first research area (see Figure 3.1, p.28), *cross-cultural influences to students attitudes towards mathematics*, indicates that attitudinal differences do appear between Asian and American students (Campbell & Connolly 1984; Caplan, Choy & Whitemore 1992; Huang 1993). However, the literature does not provide comparative information with regard to Australian and Asian born students' attitudes towards first-year university mathematics. To facilitate this aspect of the study, the countries of students' births and the countries in which they completed their high school study become the criteria for dividing students groups into the three categories G1, G2 and G3, described in section 3.2. This first research area gave rise to the following issues:

- Is there a difference in attitude towards Australian first-year university mathematics between students with different family cultural backgrounds?

- Is there a difference in attitude towards Australian first-year university mathematics between students who studied final year secondary mathematics in different countries ?

The second focus area of this study is the effect of transition on students as they move between year 12 and Australian first-year university mathematics (see Figure 3.1, p.28). This 'transition problem' appears in both Australia and Asian countries, and recent Australian (Barling, Johnston & Jones 1989; McAndrew, Murray, Armour&Thomas 1994; McInnes & James 1995) and Asian studies (Pongboriboon 1992) have discussed some problems and causes within this transition. Although there is some literature from the United States discussing learning outcomes and previous learning experiences (Uguroglu & Walberg 1979; Clarke 1984; Gross 1988; Lehmann 1987; Thorndike 1991), there appeared to be no evidence of responses regarding the transition problem from a student's perspective.

To gather information on cultural aspects of the transition problem from a student's perspective in an Australian context, two different transition paths between year 12 and first year university study have been examined:

- from Australian year 12 to an Australian university. The subjects are Australian first-year university students who come from Australian senior high schools;

from overseas senior high schools to an Australian university. The subjects are Australian first-year university students who have come from senior high schools in Asian countries.

Within these two major areas of interest, three foci have been used to guide the item development for the questionnaire. The selection of these three foci are informed by the work of Klausmeier (1985), who suggested that formed attitudes have three components: a cognitive component (information), an affective component (feelings and emotions), and a learned component (observing and imitating, by receiving reinforcement, by gaining information). The use of these foci provided the questionnaire design with three types of questions: (i) questions regarding attitudes and learning abilities, (ii) questions regarding attitudes and learning enthusiasm, and (iii) questions regarding attitudes and learning endeavour. An overview of the questionnaire design is shown in Figure 3.1 (p.28). A justification of each of these types of question, in terms of the existing literature, follows.

Regarding the first focus, students' *attitudes and learning abilities*, there are some useful comments presented in the literature.

For example, students' attitudes towards learning abilities are associated with:

- *Self-concept*, that is how students view themselves as learners, and *academic achievement*. It has been reported that academic self-concept had significant positive effects on mathematics scores (Ali 1984; Payne 1992; Wong 1992)

- *Self-assessment* that is, students' ability to accurately evaluate their ability and performance (Johnson 1982)

- *Peer or group influences*. Ability and attitudes have differential linear relations to the aspirations for children from the various groups (Marjoribanks 1987, 1988 & 1991)

- *Previous learning experiences* (Gross 1988; Fishbein 1990) and

- *Career preferences and plans* (Baker 1989)

Finally, it appears that these studies suggest that there are a number of different but related factors that impinge upon attitude formation. It is possible that the variety of results reached derive from the different understandings of the concept of 'ability'. It appears, therefore, that it might be important to clarify the way in which 'ability' is used before examining its effective and affective factors.

For the purposes of this project, it is suggested that 'ability' can be viewed as either *innate* ability or *demonstrated* ability (Lindgren, Byrne & Petrinovich 1968; Woolfolk 1993). Innate ability is mostly associated with the learning abilities arising from the mind, rather than learned from experiences. Demonstrated ability is mostly associated with the ability arising from learned experiences. By distinguishing between these two categories, it is made somewhat simpler to clarify the interaction between students' attitudes and their learning ability. In particular, it is possible that students' responses to *demonstrated* ability would provide some useful information regarding teaching and learning methods.

As an outcome of this added definitional level, the questionnaire contained specific response items which were designed to elicit answers to the general question:

Do students' attitudes towards innate ability and demonstrated ability differ in students who have different family backgrounds or who have studied the final year of secondary mathematics in a different country ?

The specific response items related to *innate ability*, which included the perceived link between:

problem-solving ability and mathematics learning success, were Items 10 and 11;

10. I believe problem solving ability is very important for getting good mathematics results at school

11. I believe problem solving ability is very important for getting good mathematics results at university

memory and learning results, were Items 20 and 21;

20. I believe good memory is important for learning mathematics at school

21. I believe good memory is important for learning mathematics at university

confidence and mathematics success, were Items 28 and 29;

28. I feel confident of doing well in mathematics at university

29. I felt confident of doing well in mathematics at school

The specific response items related to *demonstrated ability*, which included the perceived link between:

the concept of intelligence and mathematics achievement, were Items 2 and 3;

1. I believe that students who perform well in mathematics at school will perform well in mathematics at university.

2. *I believe people who are good at school mathematics are intelligent.*

3. *I believe people who are good at university mathematics are intelligent.*

successful learning results and mathematical learning ability, were Items 12 and 13;

12. *When I did well in mathematics at university it was because of my ability.*

13. *When I did well in mathematics at school it was because of my ability.*

poor learning results in mathematics and a lack of ability, were Items 14 and 15 ;

14. *When I did poorly in mathematics at school it is because of my lack of ability.*

15. *When I did poorly in mathematics at university it is because of my lack of ability*

memorising and mathematics learning, were Items 34 and 35;

34. *I believe university mathematics is mainly learnt by memorising rules and formula.*

35. *I believe school mathematics is mainly learnt by memorising rules and formula.*

The second focus concerned students' *attitudes and learning enthusiasm* to mathematics learning. The literature reviewed indicates that there is different encouragement, motivation and ideas of mathematics among students who studied in different countries. For example:

- Feather (1986) has observed that differences in cultural psychology and cultural values appear between Australian and Chinese students

- differences in motivation and the perception of the usefulness of mathematics have been detected between Japanese and Australian Asian students (Iben 1988; Mullis 1992)

- differences in student acceptance of parental values appear between American, Chinese, and Japanese students (Cheng 1991).

- differences in career interest and maintenance of career direction appear between male and female students (Thorndike 1991; Hamlett 1991).

- enjoyment and interests in mathematics appear to be related to high and low achievers' groups (Foster 1978). Moreover, a higher proportion of successful school leavers conceived mathematics only as numbers, rules, and formulae that can be applied to solve problems rather than being linked to emotional concerns (Crawford 1993).

Although the studies referred to above indicate that there are differences regarding learning enthusiasm which appear between students from different cultural backgrounds, the evidence is still not sufficient to contribute adequately to the Australian context.

In addition, it has been suggested that it is important to define more precisely the concept of 'learning enthusiasm' before discussing its related effective and affective factors (Krech & Crutchfield 1974; Woolfolk 1993). This project consequently focuses on two categories of learning drive, the intrinsic, or innate drive, and the extrinsic, or external drive. The above literature can be divided into these two categories:

Literature in the category of *intrinsic drive* includes self-expectation (Feather 1986), enjoyment of mathematics (Foster 1978), and an ideal career plan (Thorndike 1991;

Hamlet 1991). Literature in the category of *extrinsic drive* includes social values (Feather 1986), peer and parental influences (Cheng 1991).

As a result of these previous studies, the general question of interest linking attitudes and learning enthusiasm became:

Does enthusiasm towards mathematics learning differ between students who have different family backgrounds or between those who have studied for their final year of secondary mathematics in different countries ?

The specific response items related to *intrinsic drive*, which included the perceived link between learning enthusiasm and:

the learning purpose and ideas of mathematics and calculations, were Items 6 and 7;

6. *The main reason I studied mathematics at school was to learn how to do calculations.*

7. *The main reason I studied mathematics at university was to learn how to do calculations.*

the ideas of mathematics using graphs and charts, were Items 30 and 31

30. *I believe graphs and charts help people understand university mathematics ideas.*

31. *I believe graphs and charts help people understand school mathematics ideas.*

mathematical enjoyment, were Items 22 and 23

22. *I believe that the mathematics I did at school brought enjoyment to my life.*

23. *I believe that the mathematics I did at university brought enjoyment to my life.*

37. I believe university mathematics is more enjoyable than year 12 mathematics.

learning preference, were Items 8 and 9

8. *I preferred mathematics at school when it could be applied to real life situations.*

9. *I preferred mathematics at university when it could be applied to real life situations.*

The specific response items related to *extrinsic drive*, which included the perceived link between learning enthusiasm and:

learning beliefs and mathematics usefulness in a career plan, were Items 4 and 5.

4. *I believe that studying university mathematics is important for my future job.*

5. *I believe that studying school mathematics is important for my future job.*

attitudes and group work, were Items 24 and 25.

24. *I preferred to do school mathematics on my own.*

25. *I preferred to do university mathematics on my own.*

enjoyment from learning milieu, were Items 42 and 43.

42. *I liked the way mathematics was taught in year 12.*

43. *I liked the way mathematics was taught in university.*

parental expectation and influence, were Items 44, 45 and 50.

44. *I believe that my parents expected me to do well in mathematics at school.*

45. *I believe that my parents expected me to do well in mathematics at university.*

50. *I like my parents to show an interest in my study.*

The third focus concentrated upon the link between *attitudes and learning endeavour*, by which is meant the degree of effort and learning strategies that the student brought to tasks involved with mathematics learning.

The reviewed literature which discussed students' attitudes and learning endeavours within the context of mathematics study, reported significant differences in students who were born in countries with different cultural values. In addition, studies have indicated that students' learning endeavour, which is associated with learning outcomes, have been associated with factors related to the educational setting. For example:

- Previous experience in learning effort influence future performance (Entwistle 1990)
- Affective factors regarding learning endeavour and outcome, including task difficulty, homework and learning strategies (Peng 1984; Ryckman & Mizokawa 1988; Lewis 1989; Izawa 1989; Wong 1992; Wood & Smith 1993;)
- Support and encouragement from the social setting (Resnick 1990; Caplan, Choy & Whitmore 1992)
- Self and parental expectations. (Wong & Cheng 1991)

Again, the literature does not provide evidence regarding students who are studying first-year mathematics in Australia and were born, or studied final year secondary mathematics, outside Australia. To contribute to this evidence, the following general question was formulated:

Does learning endeavour towards mathematics learning differ between students who have different family backgrounds or between those who have studied for their final year of secondary mathematics in different countries ?

The specific response items related to *learning endeavour*, which included the perceived link between:

learning effort and successful learning results, were Items 16 and 17

16. *When I did well in mathematics at university it was because I worked hard.*

17. *When I did well in mathematics at school it was because I worked hard.*

poor learning results and lack of effort, were Items 18 and 19.

18. *When I did poorly in mathematics at university it was because of my lack of effort.*
19. *When I did poorly in mathematics at school it was because of my lack of effort.*

university mathematics and its perceived difficulty, was Item 36.

36. *I believe university mathematics is harder than year 12 mathematics.*

learning organisation and helpfulness to learning, were Items 38 and 39.

38*I believe the organisation of the mathematics course in year 12 was helpful for my learning.*
39. *I believe the organisation of the mathematics course in university was helpful for my learning.*

effort and the organisation of assessment in the mathematics course, were Items 40 and 41.

40. *I believe the organisation of assessment in year 12 made me worked hard throughout the year.*
41. *I believe the organisation of assessment in university made me worked hard throughout the year.*

group work and mathematics learning, were Items 26 and 27.

26. *I preferred to do school mathematics in small discussion groups.*
27. *I preferred to do university mathematics in small discussion groups.*

results and quality of teachers and lecturers, were Items 32 and 33.

32. *I believe it is possible to get good mathematical results at school without good mathematics teachers.*
33. *I believe it is possible to get good mathematical results at university without good mathematics lecturers.*

parental encouragement and insistence on mathematical study, were Items 46, 47, 48 and 49.

46. *My parents encouraged me to study hard at school.*
47. *My parents encouraged me to study hard at university.*
48. *When I was at school, my parents insisted that I study hard.*
49. *My parents insist that I study hard at university.*

3.4.3 Pilot Survey

Before presenting the questionnaire to the target population a pilot study consisting of twenty-four students was carried out. This pilot study was thought particularly important in this study since the specific item responses have not previously been used with Australian first-year university mathematics students. The pilot survey was conducted in October 1993, using the first draft of the questionnaire, which consisted of forty-three questions. The pilot questionnaire is attached as Appendix I.

The twenty-four first-year mathematics students who participated in the pilot survey were selected from the Department of Computing and Mathematics Sciences at Victoria University of Technology. These students were born in a number of countries including Australia, Cambodia, China, Eritrea, Hong Kong, India, Lebanon, Sri Lanka and Vietnam. The completed questionnaires were classified into the three groups G1, G2 and G3 as defined in section 3.3. Upon division, it was found that Group 1 contained seven students, Group 2 contained eight students, and Group 3 contained nine students.

A common Likert scale of -5, -3, -1, 1, 3, 5 was used in each question to elicit the strength of students' positive and negative responses. In this Likert scale, -5 represents 'disagree strongly', -3 represents 'disagree', -1 represents 'disagree slightly', 1 represents 'agree slightly', 3 represents 'agree', 5 represents 'agree strongly'. Each student was constrained to choose only one value in each question, and no fractional values are used in the data entry.

To present the complete data distribution for the pilot study, the raw data was analysed using the SPSS package for small size sample. Group parameters were entered into the Excel spreadsheet that provided the graphical presentation given in Figure 3.3.

The results of this pilot survey indicated that the questionnaire was capable of discriminating between the attitudes of Australian and Asian born students towards mathematics learning. For example, in specific response items related to learning endeavour (18 and 19), Asian students (G2) indicated that they believed that their effort in learning mathematics was related more positively to learning outcomes (2.8 and 2.8), whilst Australian students (G1) were uncertain (0.5 and 0.6).

With numerical data of this type, there are several acceptable ways to measure the reliability of the collected data (Nunnally 1978; Norusis 1993). One of the most commonly used reliability coefficients is Cronbach's Alpha (α), which is 'a measure based on the internal consistency of the items' (Norusis 1993, p.149). This has been used in measuring the reliability of the data in this project.

In order to demonstrate the statistical significance of the responses from the different groups, F-test, t-test and reliability coefficient calculations were used (Shavelson 1988). For the two items mentioned above, the confidence level of the differences shown was 95% and the reliability coefficient α=0.8.

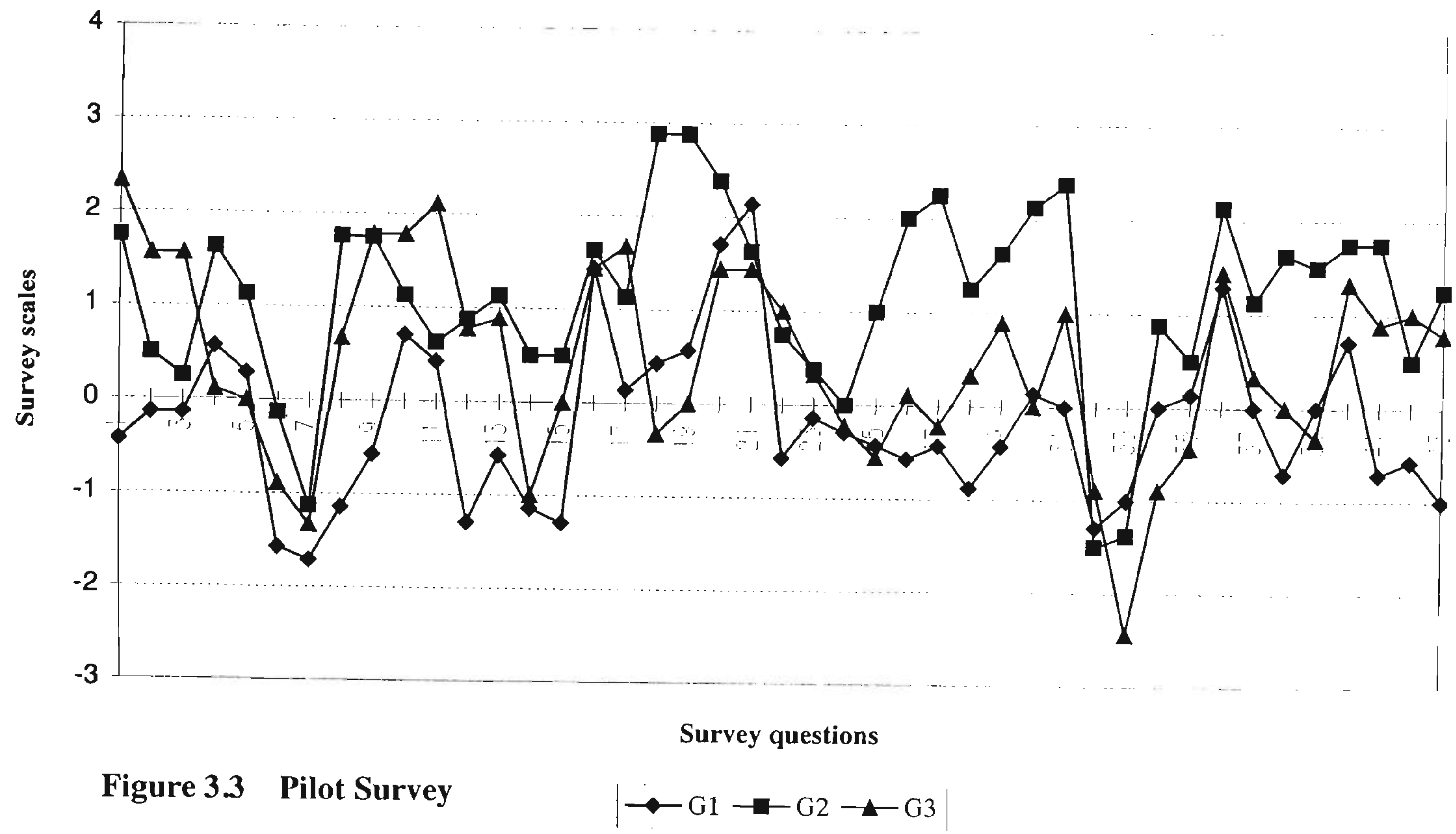


Figure 3.3 Pilot Survey

3.4.4 Main Survey and ethics considerations

The main survey was conducted in October 1994, and involved three hundred and four students who were studying in mathematics courses at the Victoria University of Technology. The purpose of this survey and its methodology were explained to the students by means of an attached front sheet before they answered the questionnaire. The cover sheet informed the students that this was a voluntary survey and there was no time limit for its completion. This information was read to the students in a class situation by their subject lecturer before distribution. Students answered the questionnaire individually, and their completed surveys were collected by the lecturers. Responses were kept confidential and all original data and related file records have been kept in hard copy, stored in a locked steel cabinet, and on computer software.

3.4.5 Analysing and description of the data.

The three hundred and four completed questionnaires were entered into the SPSS package on the IBM mainframe at the Victoria University of Technology. As with the pilot survey, group parameters were entered into the Excel spreadsheet to provide graphical presentations. These are presented in Chapter 5. Differences between the three target groups' average responses were examined using either an F-test or a t-test which are facilities available to SPSS. Tables summarising the results of F-tests and t-tests are given in Chapter 4.

3.4.6 Interpreting and analysing data results

The research question which forms the basis for this work is couched in terms of examining differences between attitudes held by various types of students at Victoria University of Technology. Consequently, the statistical tests of difference, the F-tests and t-tests, play a central role in the analysis. The analysis in Chapter 4 begins with a description of the responses of the various groups to the specific items of the questionnaire, in terms of central tendency and spread on a six-point Likert scale, and these results are displayed in Section 1 in tabular form.

Section 2 of Chapter 4 presents the results of statistical inference (difference) tests. The F-test (one-way ANOVA) was used to determined which responses could be used to discriminate between the various groups at the 95% confidence level and, as a result, twenty-one of the fifty specific item responses were shown to be available for further analysis.

These twenty-one specific response items were then used to test the differences between the three pairs of group: G1 and G2, G1 and G3, and G2 and G3. Two investigations of difference were tested using non-matched t-tests, according to the two areas of interest determined by the research question. These were:

Area 1. Is there a difference in attitude towards Australian first-year university mathematics between students with different family cultural backgrounds?

Area 2. Is there a difference in attitude towards Australian first-year university mathematics between students who studied final year secondary mathematics in different countries ?

Results of these tests are tabulated in Chapter 4.

Chapter 5 presents the interpretation of the statistical analysis presented in Chapter 4. The interpretation is carried out in sections suggested by the design of the questionnaire presented in Figure 3.1 (see p.28).

Chapter 4 Data Statistical Analysis

4.0 Introduction

Students' responses to the questionnaire used in the main survey were analysed using statistical methods that are described in the three sections of this chapter, and are presented in schematic form in Figure 3.2 (p.29). *Section 1* describes the data distributions for the specific item responses for the three target groups, and is transformed to give students' combined responses to each item. The nature and characteristics of the distribution of responses were described using measures of central tendency (mean, median and mode) and measures of dispersion (semi-interquartile range, standard deviation and standard error) which are displayed in Tables 4.1a, b and c. Comparison of these measures allowed a decision to be made on the nature of the distribution of the data in categories labelled unimodal, bimodal, flat, negative or positive skew, or approximately normal.

Section 2 presents the statistical inferences that were made regarding attitudinal differences and similarities between the target groups that represented the main focus of this project. The final conclusions and statistical decisions of whether the attitudes of the different student groups were significantly different were made in this section. These statistical inferences are based upon ANOVA (F-test) to determine similarities and differences between groups (Table 4.2a) and, for the areas where significant differences were indicated, t-tests for non-matched data and matched data were used to examine the source of these differences (Table 4.2b and c). All decisions of statistical significance were made at the 95% confidence level.

Section 3 presents statistical results relating to the three specific aspects of attitude toward mathematics learning (attitudes and innate learning abilities, attitudes and learning enthusiasm, attitudes and learning effort) which are further presented in graphical form in Chapter 5.

This chapter presents a statistical analysis using standard procedures. The justification of using standard procedure in this project is as Box and Jones (1986) indicate:

> Although more elaborate methods, some of which are mentioned in Nair's article, are available, we have usually analysed such data with standard procedures.
>
> It may be argued that such analysis is inappropriate because (a) the scale is subjective, (b) it is discrete rather than continuous, and (c) the necessary distributional assumptions are not satisfied. We feel that the first objection does not carry much weight, provided that the scale is carefully and thoughtfully chosen by a consensus of knowledgeable people and bearing in mind that the final results will be expressed on the same scale. On the second and third points, it is known that standard statistical procedures are remarkably robust to drastic rounding and to departures from distributional assumptions (p.295).

4.1 Section 1 : Data distribution

Section one is a statistical description of data distributions regarding the three groups' responses (G1: born and studied year 12 in Australia, G2: born Overseas, but studied year 12 in Australia, G3: born and studied year 12 in Asian Countries) to the specific items. Each group's data distribution is described separately through ***central tendency*** and ***variability***.

4.1.1 The theory of data distribution

The ***Central tendency*** of data distribution describes the location of the centre of students' responses distribution in each group by indicating one score value. This is to characterise an 'average' or 'typical' score value in the distribution, describing the 'centre of gravity' of students' responses in each group. The measures of central tendency commonly used are mean, median and mode. The preferred measure depends on the shape of the distribution and the purpose of data interpretation. In a normal distribution, mean, median and mode are identical but, more commonly, samples are skewed. In skewed distributions, the mean, median and mode have different values and provide different indications. In order to describe more fully the nature of the data distribution, the three measures are presented in this section (Table 4.1a, b and c).

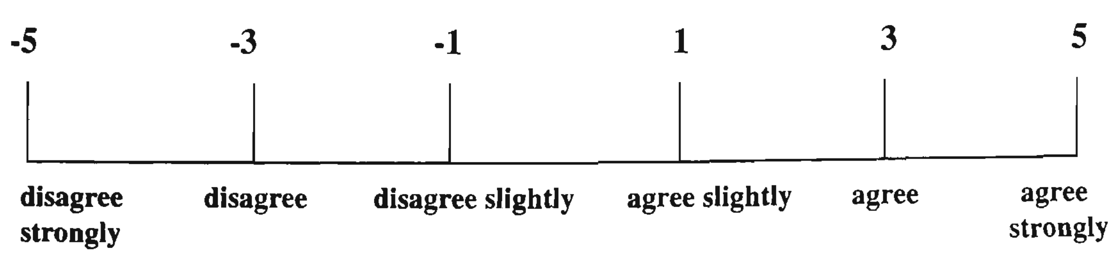
The ***variability*** of data distribution in this chapter describes data spread or range of the data distribution of each group's responses. Five scale values are used to measure students' responses. The greater the differences between scale values answered by students in a group, the more spread out (or scattered) the scale values are in a distribution. Variability is used to characterise 'density' or 'scattering' of the score value in each question, and describes the data consistency level. The measures of variability commonly used are *Range, Semi-interquartile range (SIQR), Standard deviation (s),* and *Standard error of mean* (σ)*.* Each of them can provide the description of data variability in different ways. Since *Range* is determined by the two most extreme scale values (eg. -5 and 5) in the Likert scales -5, -3, -1, 1, 3, 5, it does not usefully reflect the pattern of the variation in the distribution. Therefore, three more useful measures of variability of data distribution are presented in this project: SIQR, s, and σ.

Semi-interquartile range (SIQR) is one-half the difference between the score values at the 75th and 25th percentiles. Because SIQR focuses on the middle 50 percent of the scores, it is much less affected by extreme scores than is *Range*. Therefore, SIQR is often used as a measure of variability in skewed distribution which have a few extremely high or extremely low scores. This project uses SIQR to describe the data variability (spread) in the questions where the data distribution are skewed. The specific purpose of using SIQR in this project is to identify the trend of the majority of students in each group, since this measure is relatively unaffected by extreme scale values.

Standard Deviation (s) is an average variability of scores in the distribution measured in units of the original score scale. Standard deviation is a more stable measure of variation than *Range* or SIQR. It uses all scores in the distribution, providing a more inclusive measure of variation. This project presents the standard deviation of each question to describe the variability of students' responses, and to assist in further analysis carried out in parts 2 and 3.

Standard Error of Mean (σ) is the standard deviation of sample means in a sampling distribution of means. It provides an index of how much the sample means vary about the population mean. It is used to provide information about the amount of error likely to be made by inferring the value of the population mean from a single sample mean. The greater the variability among sample means, the greater the chance is that the inferences about the population mean from a single sample mean will be in error. There are two specific purposes of using σ in this project. First, the confidence interval (C.I.) of the mean can be described through σ. The mean is the major statistic used in the project, as all data interpretation and analysis are based on the group average responses. It is important to have detailed information about the confidence interval of the mean by estimating how much the group's mean varies about the population mean (the mean of the sampling distribution). Second, the σ is used in the t-test as described in part two.

In this project, a common Likert scale is used as -5, -3, -1, 1, 3, 5 in each question to elicit the strength of students' positive and negative responses. In this Likert scale, -5 represents 'disagree strongly', -3 represents 'disagree', -1 represents 'disagree slightly', 1 represents 'agree slightly', 3 represents 'agree', 5 represents 'agree strongly'. Each student was constrained to choose only one value in each question, and no fractional values are used in the data entry.



The raw data was obtained from the revised questionnaire. It has been analysed using the Statistical Package of Social Sciences (SPSS) on an IBM computer at Footscray Park Campus of Victoria University of Technology.

4.1.2 Central Tendency and Variability of the data results

Three tables (Table 4.1a, 4.1b, 4.1c) in this section show the three groups' responses through seven statistics: Mean, Median, Mode, Semi-interquartile range, Standard deviation, Standard Error of Mean, and 95% Confidence Interval.

These statistics have been used to provide information regarding the nature of the distribution of responses which could be either unimodal, bimodal, flat (platykurtic) or normally distributed. The definitions and conditions used in this work for these distributions are:

- *Unimodal I*, represents distributions in question responses which are negatively skewed. This type of distribution can be deduced from the relationship

    Mean < Median as shown in Figure 4.1a.

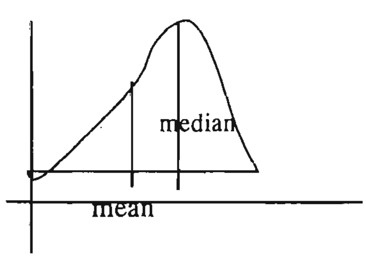


Figure 4.1a Negative skewed

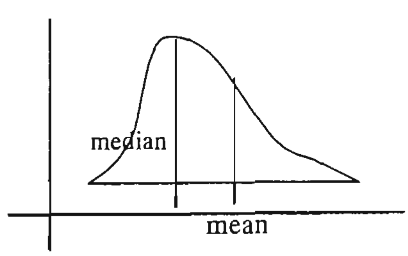


Figure 4.1b Positive skewed

- *Unimodal II* indicates questions with positive skewed distribution. Here the Mean>Median as shown in Figure 4.1b.

In both of these case the skew results from the sensitivity of the mean to extremely small (unimodal I) or extremely large (unimodal II) results.

- *Unimodal III* indicates questions with normal distribution or bimodal distribution.

If the Mean ≅ Median ≅ Mode, the distribution is approximately normally distributed.

The bimodal category indicates questions with two local peaks in its distribution. Since the allocation of the student groups yielding these distributions are ambiguous, further investigation would be needed to interpret these trends. Some reference has been made to these cases in the data interpretation section in Chapter 5.

The type of distribution of each question is noted in Column I of the Tables 4.1a, b and c.

Greek letter (Alpha) α denotes the level of significance that represents the probability of an unlikely sample result and for this project α has been chosen as 0.05. The confidence interval is used to estimate the true value of the population mean and to construct an interval in to which the population mean is likely fall. Because Standard Deviation (**s**) is available, the confidence interval was calculated using the formula:

Mean $\pm$ allowance factor, where allowance factor = $\mathbf{t}_{(\alpha/2,\, df)}\ s/\sqrt{n}$.

For example, if α =0.05, **df**=177, $\mathbf{t}_{(0.025,\, 177)}$=1.98,

the 95% confidence interval = mean $\pm 1.98\ s/\sqrt{177}$,

It is noted that in the case where n>40, the t-critical value approaches z-critical at 95% (i.e. 1.96).

The result obtained and displayed in the following tables.

Table 4.1a Statistical description of Group G1 data (n=177)

Questions	G1 Mean	G1 Median	G1 Mode	G1 SIQR	G1 St.Dev.	G1 S.E.Mean	G1 95% C.I
unimodal I negative skewed	Mean <	Median	Mode				
Q 1	1.66	3.00	3.00	1	2.34	0.18	[1.3 – 2.02]
Q 4	2.45	3.00	3.00	2	2.31	0.17	[2.11 – 2.79]
Q 5	2.24	3.00	3.00	1	1.86	0.14	[1.96 – 2.52]
Q 8	1.55	3.00	3.00	1.5	2.85	0.21	[1.13 – 1.97]
Q 9	2.02	3.00	3.00	1	2.45	0.18	[1.66 – 2.38]
Q 10	2.20	3.00	3.00	1	2.22	0.17	[1.86 – 2.54]
Q 11	2.19	3.00	3.00	1	2.37	0.18	[1.83 – 2.55]
Q 12	1.68	3.00	3.00	1	2.35	0.18	[1.32 – 2.04]
Q 13	1.99	3.00	3.00	1	2.34	0.18	[1.63 – 2.35]
Q 16	2.75	3.00	3.00	0	1.89	0.14	[2.47 – 3.03]
Q 17	2.51	3.00	3.00	1	2.09	0.16	[2.19 – 2.83]
Q 18	2.13	3.00	3.00	1	2.38	0.18	[1.77 – 2.49]
Q 19	1.90	3.00	3.00	1	2.61	0.20	[1.50 – 2.30]
Q 20	2.46	3.00	3.00	1	2.07	0.16	[2.14 – 2.78]
Q 21	2.57	3.00	3.00	2	2.13	0.16	[2.25 – 2.89]
Q 22	-1.70	-1.00	-5.00	3	2.71	0.20	[-2.10 – -1.30]
Q 28	0.92	1.00	1.00	2	2.22	0.17	[0.58 – 1.26]

Q 29	1.67	3.00	3.00	1	2.37	0.18	[1.31 – 2.03]
Q 36	2.43	3.00	3.00	2	2.37	0.18	[2.07 – 2.79]
Q 38	0.76	1.00	1.00	2	2.50	0.19	[0.38 – 1.14]
Q 40	0.52	1.00	1.00	2	2.78	0.21	[0.10 – 0.94]
Q 41	0.59	1.00	3.00	2	2.48	0.19	[0.21 – 0.97]
Q 42	0.88	1.00	1.00	2	2.69	0.20	[0.48 – 1.28]
Q 43	0.99	1.00	1.00	2	2.49	0.19	[0.61 – 1.37]
Q 44	2.52	3.00	3.00	1	2.08	0.16	[2.20 – 2.84]
Q 45	2.36	3.00	3.00	1	2.17	0.16	[2.04 – 2.68]
Q 46	2.73	3.00	3.00	2	2.21	0.17	[2.39 – 3.07]
Q 47	2.70	3.00	3.00	2	2.27	0.17	[2.36 – 3.04]
unimodal II positive skewed	**Mean >**	**Median**	**Mode**				
Q 26	1.07	1.00	1.00	2	2.63	0.20	[0.67 – 1.47]
Q 27	1.41	1.00	3.00	1.5	2.61	0.20	[1.01 – 1.81]
Q 30	1.03	1.00	1.00	2	2.45	0.18	[0.67 – 1.39]
Q 31	1.06	1.00	1.00	2	2.37	0.18	[0.70 – 1.42]
Q 39	1.03	1.00	1.00	1.25	2.31	0.17	[0.69 – 1.37]
Q 48	1.44	1.00	3.00	2	2.90	0.22	[1.00 – 1.88]
Q 49	1.40	1.00	3.00	2	2.94	0.22	[0.96 – 1.84]
Q 50	1.23	1.00	1.00	2	2.84	0.21	[0.81 – 1.65]
Q 14	-0.70	-1.00	-3.00	2	2.81	0.21	[-1.12 – -0.28]
Q 15	-0.69	-1.00	-1.00	2	2.76	0.21	[-1.11 – -0.27]

Q 23	-1.96	-3.00	-3.00	2.5	2.56	0.19	[-2.34 – -1.58]
Q 32	-1.86	-3.00	-5.00	3	3.05	0.23	[-2.32 – -1.40]
Q 33	-2.06	-3.00	-5.00	2	2.95	0.22	[-2.50 – -1.62]
Unimodal III	**Mean**	**Median**	**Mode**				
Q 2	-0.02	1.00	1.00	1	2.47	0.19	[-0.40 – 0.36]
Q 3	0.63	1.00	1.00	2	2.41	0.18	[0.27 – 0.99]
Q 6	-0.41	-1.00	-1.00	2	2.76	0.21	[-0.83 – 0.00]
Q 7	-0.51	-1.00	-3.00	2	2.73	0.21	[-0.93 – -0.09]
Q 24	0.25	1.00	3.00	2	2.63	0.20	[-0.15 – 0.65]
Q 25	0.01	-1.00	-1.00	3	2.70	0.20	[-0.39 – 0.41]
Q 34	0.21	1.00	1.00	2	2.70	0.20	[-0.19 – 0.61]
Q 35	0.23	1.00	1.00	1	2.55	0.19	[-0.15 – 0.61]
Q 37	-0.21	1.00	1.00	2	2.79	0.21	[-0.63 – 0.21]

Summary :

Unimodal I	**28**
Unimodal II	**13**
Unimodal III	**9**

Table 4.1b **Statistical description of Group G2 data (n=97)**

Questions	G2 Mean	G2 Median	G2 Mode	G2 SIQR	G2 St.Dev.	G2 S.E.Mean	G2 95% C.I.
unimodal I negative skewed	**Mean <**	**Median**	**Mode**				
Q 1	2.28	3.00	3.00	1	2.33	0.24	[1.80 – 2.76]
Q 4	2.01	3.00	3.00	1	2.43	0.25	[1.52 – 2.51]
Q 5	1.64	3.00	3.00	1	2.19	0.22	[1.20 – 2.08]
Q 8	1.72	3.00	3.00	1	2.60	0.26	[1.21 – 2.23]
Q 9	2.07	3.00	3.00	1	2.36	0.24	[1.59 – 2.55]
Q 10	2.48	3.00	3.00	1	2.15	0.22	[2.04 – 2.92]
Q 11	2.55	3.00	3.00	1	2.25	0.23	[2.09 – 3.01]
Q 12	1.95	3.00	3.00	1	2.42	0.25	[1.46 – 2.45]
Q 13	1.93	3.00	3.00	1	2.24	0.23	[1.47 – 2.39]
Q 18	2.71	3.00	3.00	1.5	2.31	0.23	[2.25 – 3.17]
Q 19	2.65	3.00	3.00	2	2.14	0.22	[2.21 – 3.09]
Q 20	2.84	3.00	3.00	1	2.21	0.22	[2.40 – 3.28]
Q 21	2.72	3.00	3.00	2	2.24	0.23	[2.26 – 3.18]
Q 26	0.98	1.00	1.00	2	2.95	0.30	[0.39 – 1.37]
Q 28	1.64	3.00	3.00	1	2.13	0.22	[1.20 – 2.08]
Q 29	1.74	3.00	3.00	1	2.40	0.24	[1.26 – 2.22]
Q 30	0.93	1.00	1.00	1.75	2.25	0.23	[0.47 – 1.39]
Q 31	0.79	1.00	1.00	1.75	2.26	0.23	[0.33 – 1.25]
Q 36	2.46	3.00	3.00	2	2.39	0.24	[1.98 – 2.94]

Q 38	1.79	3.00	3.00	1	2.53	0.26	[1.28 – 2.30]
Q 39	1.84	3.00	3.00	1	1.93	0.20	[1.44 – 2.24]
Q 43	1.81	3.00	3.00	1	2.24	0.23	[1.35 – 2.27]
Q 44	2.44	3.00	3.00	2	2.41	0.24	[1.96 – 2.92]
Q 45	2.63	3.00	3.00	2	2.24	0.23	[2.17 – 3.09]
Q 46	2.90	3.00	5.00	1	2.49	0.25	[2.41 – 3.40]
Q 47	2.99	3.00	5.00	1	2.32	0.24	[2.51 – 3.47]
Q 48	1.88	3.00	3.00	2	2.85	0.29	[1.31 – 2.45]
Q 49	1.90	3.00	3.00	1	2.73	0.28	[1.35 – 2.45]
Q 50	2.32	3.00	5.00	2	2.68	0.27	[1.79 – 2.85]
unimodal II positive skewed	**Mean >**	**Median**	**Mode**				
Q 16	3.16	3.00	3.00	1	1.91	0.19	[2.78 – 3.54]
Q 17	3.07	3.00	3.00	1	1.79	0.18	[2.71 – 3.43]
Q 27	1.47	1.00	1.00	1	2.87	0.29	[0.90 – 2.04]
Q 40	1.10	1.00	3.00	2	2.65	0.27	[0.57 – 1.63]
Q 41	1.42	1.00	1.00	1	2.17	0.22	[0.98 – 1.86]
Q 32	-1.25	-3.00	-3.00	2	3.27	0.33	[-1.90 – 0.60]
Q 33	-1.49	-3.00	-3.00	2	3.12	0.32	[-2.12 – -0.86]
Unimodal III	**Mean**	**Median**	**Mode**				
Q 42	1.00	1.00	1.00	2	2.70	0.27	[0.47 – 1.53]
Q 2	-0.15	1.00	1.00	2	2.74	0.28	[-0.70 – 0.40]
Q 3	0.20	1.00	1.00	3	2.90	0.29	[-0.37 – 0.77]

Q 6	0.05	1.00	3.00	3	3.13	0.32	[-0.58 – 0.68]
Q 7	-0.56	-1.00	-3.00	3	3.20	0.33	[-1.21 – 0.09]
Q14	0.46	1.00	3.00	3	3.06	0.31	[-0.15 – 1.07]
Q15	0.32	1.00	3.00	2.5	2.93	0.30	[-0.27 – 0.91]
Q22	0.18	1.00	1.00	3	3.01	0.31	[-0.43 – 0.79]
Q23	0.14	1.00	1.00	2	2.80	0.28	[-0.41 – 0.69]
Q 24	0.36	1.00	3.00	2	2.79	0.28	[-0.19 – 0.91]
Q 25	0.02	0	-1.00	2.5	2.77	0.28	[-0.53 – 0.57]
Q 34	0.07	1.00	-1.00	3	2.72	0.28	[-0.48 – 0.62]
Q 35	0.61	1.00	1.00	2	2.64	0.27	[0.08 – 1.14]
Q 37	0.56	1.00	1.00	2	2.44	0.25	[0.07 – 1.06]

Summary :

Unimodal I	**29**
Unimodal II	**7**
Unimodal III	**14**

Table 4.1c Statistical description of Group G3 data (n=30)

Question	G3 Mean	G3 Median	G3 Mode	G3 SIQR	G3 St.Dev.	G3 S.E.Mean	G3 95% C.I
unimodal I negative skewed	**Mean <**	**Median**	**Mode**				
Q 1	2.80	3.00	3.00	2	1.92	0.35	[2.09 – 3.51]
Q 4	2.40	3.00	3.00	1	1.98	0.36	[1.67 – 3.13]
Q 8	2.30	3.00	3.00	2	2.02	0.37	[1.55 – 3.05]
Q 9	1.87	3.00	3.00	1	2.27	0.41	[1.03 – 2.71]
Q 10	2.20	3.00	3.00	1	2.27	0.41	[1.36 – 3.04]
Q 11	2.47	3.00	3.00	2	2.29	0.42	[1.61 – 3.33]
Q 14	0.90	1.00	3.00	2	2.55	0.47	[-0.06 – 1.86]
Q 18	2.23	3.00	3.00	1.25	2.46	0.45	[1.31 – 3.15]
Q 19	2.10	3.00	3.00	1	2.58	0.47	[1.14 – 3.06]
Q 22	2.40	3.00	3.00	1	2.24	0.41	[1.56 – 3.24]
Q 23	2.80	3.00	3.00	2	1.69	0.31	[2.17 – 3.43]
Q 24	0.93	1.00	1.00	2	2.43	0.44	[0.03 – 1.83]
Q 26	2.40	3.00	3.00	1	1.90	0.35	[1.69 – 3.11]
Q 27	2.93	3.00	3.00	0.25	1.62	0.30	[2.32 – 3.54]
Q 28	2.07	3.00	3.00	1	1.64	0.30	[1.46 – 2.68]
Q 29	2.60	3.00	3.00	1	1.69	0.31	[1.97 – 3.23]
Q 30	2.33	3.00	3.00	1	2.06	0.38	[1.55 – 3.11]
Q 31	2.20	3.00	3.00	1	2.14	0.39	[1.40 – 2.30]

Q 38	2.77	3.00	3.00	0	1.38	0.25	[2.26 – 3.28]
Q 40	2.73	3.00	3.00	0.25	1.70	0.31	[2.10 – 3.36]
Q 41	2.57	3.00	3.00	0.25	2.10	0.38	[1.79 – 3.35]
Q 42	2.23	3.00	3.00	1	1.74	0.32	[1.58 – 2.88]
Q 43	2.47	3.00	3.00	1	1.81	0.33	[1.80 – 3.14]
Q 46	3.53	4.00	5.00	1	1.96	0.36	[2.80 – 4.26]
Q 47	3.47	4.00	5.00	1	2.01	0.37	[2.72 – 4.22]
Q 48	1.73	3.00	3.00	1	2.49	0.45	[0.81 – 2.65]
Q 49	1.73	3.00	3.00	1	2.49	0.45	[0.81 – 2.65]
Q 50	2.73	3.00	3.00	0	2.02	0.37	[1.98 – 3.48]
unimodal II positive skewed	**Mean ≥**	**Median**	**Mode**				
Q 5	1.07	1.00	1.00	2	2.32	0.42	[0.21 – 1.93]
Q 6	1.00	1.00	3.00	2	2.46	0.45	[0.08 – 1.92]
Q 12	2.07	2.00	1.00	1	1.36	0.25	[1.56 – 2.58]
Q 13	2.07	2.00	1.00	1	1.36	0.25	[1.56 – 2.58]
Q 16	3.18	3.00	3.00	0	1.10	0.20	[2.77 – 3.59]
Q 17	3.07	3.00	3.00	0.25	1.62	0.30	[2.46 – 3.68]
Q 20	3.13	3.00	5.00	1.25	2.34	0.43	[2.25 – 4.01]
Q 21	3.07	3.00	5.00	2	2.26	0.41	[2.23 – 3.91]
Q 36	3.20	3.00	3.00	1.25	1.69	0.31	[2.57 – 3.83]
Q 37	2.00	2.00	1.00	1	2.02	0.37	[1.25 – 2.75]
Q 44	3.10	3.00	3.00	1	2.20	0.40	[2.28 – 3.92]

Q 45	3.17	3.00	3.00	1	2.23	0.41	[2.33 – 4.01]
Q 32	-2.13	-3.00	-3.00	2.25	2.91	0.53	[-3.21 – -1.05]
Q 33	-2.47	-3.00	-5.00	2	2.83	0.52	[-3.53 – -1.41]
Unimodal III	**Mean**	**Median**	**Mode**				
Q 39	3.00	3.00	3.00	0	1.17	0.21	[2.57 – 3.43]
Q2	0.80	1.00	1.00	2	2.31	0.42	[-0.06 – 1.66]
Q3	0.93	1.00	3.00	2	2.26	0.41	[0.09 – 1.77]
Q 7	0.27	1.00	3.00	3	2.55	0.46	[-0.67 – 1.21]
Q15	0.50	1.00	3.00	2.25	2.66	0.49	[-0.50 – 1.50]
Q 25	0.60	1.00	3.00	2	2.75	0.50	[-0.42 – 1.62]
Q34	0.40	1.00	3.00	3	3.20	0.58	[-0.68 – 1.58]
Q35	0.73	2.00	3.00	3	3.18	0.58	[-0.45 – 1.91]

Summary :

Unimodal I	**28**
Unimodal II	**14**
Unimodal III	**8**

4.2 Section 2 : Statistical inference

The statistical decisions regarding the difference and similarity of the three groups are presented in this section using related statistical inference measurements of F-test and t-test. The F-test using Bonferroni, which is a specific statistical tool of the one-way analysis of variance (ANOVA), was employed to test and clarify the similarities in the groups' average responses. Subsequently, t-tests were employed to test and clarify the significance of differences in the groups' average responses. The results of the t-test are included in two tables: the first contains the results of testing non-matched data (see Tables 4.2b). The other table contains the results of testing matched data (see Tables 4.2c).

Three steps describe the procedures for conducting an F-test and t-test. The first step tests the general differences and similarities between the three groups' responses in the fifty survey questions using an F-test, and these results are given in the Table 4.2a. The results of this F-test indicate that the three groups' average responses are significantly different in twenty-one questions whilst there are no significant differences in the other twenty-nine questions.

The second step examines the groups' differences in these twenty-one questions using t-test for **non-matched** data (see Table 4.2b). Because the variances of groups' responses in each question occurred on each pair groups' average responses, the data are treated as non-matched data.

Attitudinal difference and similarities between school and university mathematics using the t-test for **matched** data (see Table 4.2c) are carried out in the third step. Because the variances of each single group's responses occurred between the questions regarding school mathematics and the questions regarding university mathematics, the data are treated as matched data.

All statistical results of both F-test and t-test were carried out using the SPSS computer program. The statistical results follow:

4.2.1 F-test for general differences and similarities

The F-test is used in this part for testing group differences and similarities between the three groups' responses to the fifty survey questions in the revised questionnaire.

Table 4.2a: Testing group differences and similarities (Using F-test)

Question	$F_{observed}$ $F_{critical}=3.04$	Question	$F_{observed}$ $F_{critical}=3.04$	Question	$F_{observed}$ $F_{critical}=3.04$
Q 1	4.434 *	Q 18	1.9168	Q 35	0.8971
Q 2	1.6604	Q 19	2.8743	Q 36	1.4533
Q 3	1.3195	Q 20	1.8337	Q 37	10.1369*
Q 4	1.1643	Q 21	0.7085	Q 38	11.9044*
Q 5	5.8946 *	Q 22	35.1335*	Q 39	13.2155*
Q 6	3.4085 *	Q 23	54.1410*	Q 40	9.2591 *
Q 7	1.0437	Q 24	0.8316	Q 41	10.7886*
Q 8	0.9947	Q 25	0.6243	Q 42	3.4669 *
Q 9	0.0838	Q 26	3.5427 *	Q 43	7.1974 *
Q 10	0.5599	Q 27	4.4798 *	Q 44	1.0652
Q 11	0.7990	Q 28	5.8644 *	Q 45	1.9086
Q 12	0.6539	Q 29	2.0887	Q 46	1.6131
Q 13	0.0529	Q 30	4.4274 *	Q 47	1.6722
Q 14	7.4918 *	Q 31	4.2503 *	Q 48	0.7819
Q 15	5.2421 *	Q 32	1.5689	Q 49	1.0002
Q 16	1.9183	Q 33	1.6613	Q 50	7.2749 *
Q 17	3.0773 *	Q 34	0.1825		

* H_0 rejected

Notes:

In Table 4.2a, the degrees of freedom $d_{fb}=2$, $d_{fw}=301$. All decisions are made at the 95% confidence level. Therefore, the $F_{critical}=3.04$, and the hypothesis of this F-test is made as:

H_0: There are no significant differences among the three groups' average responses in the tested questions.

H_1: There are significant differences among the three groups' average responses in the tested questions. The F-test results in Table 4.2a indicate that there are no significant differences in twenty-nine questions (see Table 4.2a), and the groups' average responses are significantly different in twenty-one questions marked (*), where H_0 is rejected.

Mark (*) indicates that in questions 1, 5, 6, 14, 15, 17, 22, 23, 26, 27, 28, 30, 31, 37, 38, 39, 40, 41, 42, 43, and 50, their F-observed values are greater than their critical values ($F_{observed} > F_{critical} = 3.04$). Therefore, reject H_0 at level of Alpha= 0.05 and the decision is that there is significant attitudinal difference ($p < 0.05$) among the three groups' responses in these questions.

4.2.2 The t-test for group differences in the twenty-one questions

The F-test results in Table 4.2a indicate that the groups' average responses are significantly different in twenty-one questions marked (*), where H_0 is rejected. Therefore, a t-test is used in this part for testing group differences and similarities between the three groups' responses to the twenty-one survey questions in the revised questionnaire.

Table 4.2b. Testing group differences in the twenty-one questions using t-test

Results / Questions	G1(177) and G2(97) $t_{critical}$ =1.96	G1(177) and G3(30) $t_{critical}$ =1.96	G2(97) and G3(30) $t_{critical}$ =2.042
Q 1	t_{ob}=-2.09 *	t_{ob}=-2.53 *	t_{ob} =-1.11
Q 5	t_{ob} =2.41 *	t_{ob} =3.09 *	t_{ob} =1.23
Q 6	t_{ob} =-1.27	t_{ob} =-2.63 *	t_{ob} =-1.52
Q 14	t_{ob} =-3.18 *	t_{ob} =-2.93 *	t_{ob} =-0.71
Q 15	t_{ob} =-2.83 *	t_{ob} =-2.19 *	t_{ob} =-0.30
Q 17	t_{ob} =-2.25 *	t_{ob} =-1.40	t_{ob} =0.02
Q 22	t_{ob} =-5.26 *	t_{ob} =-7.83 *	t_{ob} =-3.74 *
Q 23	t_{ob} =-6.30 *	t_{ob} =-9.83 *	t_{ob} =-4.93 *
Q 26	t_{ob} =0.25	t_{ob} =-2.66 *	t_{ob} =-2.48 *
Q 27	t_{ob} =-0.20	t_{ob} =-3.11 *	t_{ob} =-2.65 *
Q 28	t_{ob} =-2.60 *	t_{ob} =-2.70 *	t_{ob} =-1.01
Q 30	t_{ob} =0.35	t_{ob} =-2.74 *	t_{ob} =-3.05 *
Q 31	t_{ob} =0.91	t_{ob} =-2.46 *	t_{ob} =-3.02 *
Q 37	t_{ob} =-2.27 *	t_{ob} =-4.16 *	t_{ob} =-2.94 *
Q 38	t_{ob} =-3.27 *	t_{ob} =-4.28 *	t_{ob} =-2.01
Q 39	t_{ob} =-2.93 *	t_{ob} =-4.56 *	t_{ob} =-3.11 *
Q 40	t_{ob} =-1.69	t_{ob} =-4.23 *	t_{ob} =-3.17 *
Q 41	t_{ob} =-2.76 *	t_{ob} =-4.11 *	t_{ob} =-2.54 *
Q 42	t_{ob} =-0.36	t_{ob} =-2.67 *	t_{ob} =-2.35 *
Q 43	t_{ob} =-2.70 *	t_{ob} =-3.09 *	t_{ob} =-1.45

Q 50	t_{ob} =-3.09 *	t_{ob} =-2.77 *	t_{ob} =-0.78

* H_0 rejected

Notes:

All decisions in Table 4.2b are made at the 95% confidence level. The hypothesis of this t-test is made as:

H_0: There are no significant differences between the two groups' average responses in the tested questions.

H_1: There are significant differences between the two groups' average responses in the tested questions.

Consequently, Table 4.2a indicates that the three groups' responses are significantly different in twenty-one questions. A t-test is used in Table 4.2a to test differences between three paired groups' responses (G1&G2, G1&G3, G2&G3) in the twenty-one questions. The data are treated as non-matched data, since the variances of groups' responses in each question occurred on each pair groups' average responses.

In Table 4.2b, the size of three groups are G1=177, G2=97, and G3=30 and therefore, the degree of freedom **df**=n + m -2 > 120. Consequently, the three pairs of groups (G1 & G2, G1& G3, G2 & G3) have the same t-critical value, which is 1.96.

There are three kinds of results in Table 4.2b:

1. In the questions 22, 23, 37, 38, 39 and 41, the t-observed values are greater than their t-critical values ($t_{ob} > t_{critical} = 1.96$) among the three groups at the significant level of 0.05. The decision is to reject H_0, and accept that: there are significant differences among the three groups' responses.

2. In the questions 1, 5, 14, 15, 26, 27, 28, 30, 31, 40, 42, 43 and 50, there is one pair of groups in each question whose t-observed values are smaller than their t-critical values ($t_{ob} < t_{critical} = 1.96$) at the level of significance 0.05. The decision is to accept H_0, and claim that there are no significant differences between the two groups.

In the questions 6 and 17, there is one pair of groups in each question whose t-observed values are greater than their t-critical values ($t_{ob} > t_{critical} = 1.96$) at the significance level of 0.05. Therefore, the decision is to reject Ho and accept that there are significant differences between the two groups.

4.2.3 Testing the differences between school and university mathematics

Specifically, the three groups' attitudinal differences and similarities towards school and university mathematics are tested in this part using matched t-tests.

The results are shown in Table 4.2c.

Table 4.2c Testing differences and similarities of students' responses to school and university mathematics (Using t-test)

Paired questions	Group G1 (n=177) $t_{critical} = 1.96$	Group G2 (n=97) $t_{critical} = 1.98$	Group G3 (n=30) $t_{critical} = 2.042$
Q2 & Q3	t_{ob}= -5.22 *	t_{ob} = - 2.44 *	t_{ob} = - 0.49
Q5 & Q4	t_{ob}=1.21	t_{ob} =1.30	t_{ob} =3.81 *
Q6 & Q7	t_{ob} =0.62	t_{ob} =2.59 *	t_{ob} =2.48 *
Q8 & Q9	t_{ob} =-2.64 *	t_{ob} =-1.73	t_{ob} =1.34
Q10 & Q11	t_{ob} =0.07	t_{ob} =-0.42	t_{ob} =-1.44
Q13 & Q12	t_{ob} =-3.09 *	t_{ob} =-0.71	t_{ob} =0
Q14 & Q15	t_{ob} =-0.10	t_{ob} =1.26	t_{ob} =1.24
Q17 & Q16	t_{ob} =2.44 *	t_{ob} =0.69	t_{ob} =0.55
Q19 & Q18	t_{ob} =1.87	t_{ob} =0.56	t_{ob} =0.53
Q20 & Q21	t_{ob} =-1.34	t_{ob} =0.97	t_{ob} =0.44

Q22 & Q23	t_{ob} =1.99 *	t_{ob} =0.16	t_{ob} =-1.65
Q24 & Q25	t_{ob} =1.89	t_{ob} =1.82	t_{ob} =0.84
Q26 & Q27	t_{ob} =-2.74 *	t_{ob} =-2.26 *	t_{ob} =-1.86
Q28 & Q29	t_{ob} =-3.06 *	t_{ob} =-0.49	t_{ob} =-1.61
Q31 & Q30	t_{ob} =-0.45	t_{ob} =1.04	t_{ob} =0.81
Q32 & Q33	t_{ob} =1.31	t_{ob} =0.93	t_{ob} =1.09
Q35 & Q34	t_{ob} =-0.15	t_{ob} =-2.63 *	t_{ob} =-1.00
Q38 & Q39	t_{ob} =-1.34	t_{ob} =-0.17	t_{ob} =-0.96
Q40 & Q41	t_{ob} =-0.30	t_{ob} =-1.21	t_{ob} =0.42
Q42 & Q43	t_{ob} =-0.41	t_{ob} =-2.57 *	t_{ob} =-0.48
Q44 & Q45	t_{ob} =1.92	t_{ob} =-1.32	t_{ob} =-1.00
Q46 & Q47	t_{ob} =0.24	t_{ob} =-0.88	t_{ob} =0.57
Q48 & Q49	t_{ob}=0.34	t_{ob} =-0.12	t_{ob} =0.00

Notes:

- Because the variances of each single group's responses occurred between the questions regarding school mathematics and the questions regarding university mathematics, the data are treated as matched data.

- All paired question numbers are in the first column, the first number represents the question related to school mathematics, and the second number represents the question related to university mathematics. For example, in Q2 & Q3, question 2 relates to school mathematics, question 3 relates to university mathematics.

- * $p < 0.05$, the level of significance is Alpha = 0.05. The three groups have different t values for different questions as follows:

Group G1 indicates that the t-observed value is greater than the t-critical value ($t_{ob} > t_{cri} = 1.96$) in the question pairs: Q2 & 3, Q8 & 9, Q13 &12, Q17&16, Q22 &23, Q26 &27, Q28 &29.

Group G2 indicates that the t-observed value is greater than the t-critical value ($t_{ob} > t_{cri} = 1.98$) in the question pairs: Q2 & 3, Q6 & 7, Q26 &27, Q35 &34, Q42 &43.

Group G3 indicates that their t-observed value is greater than the t-critical value ($t_{ob} > t_{cri} = 2.042$) in the question pairs: Q5 &4, Q6 &7.

4.3 Section 3: Statistical results of three specific aspects

This part tests three specific aspects of *learning ability, learning enthusiasm and learning endeavour*. Following are statistical results focusing on these three aspects, and forming three components:

- Students' attitudes regarding mathematical learning ability
- Students' attitudes regarding mathematical learning enthusiasm
- Students' attitudes regarding mathematical learning endeavour

4.3.1 Aspect one: Students' attitudes regarding mathematical learning ability

The question set regarding learning ability contains questions numbered 1, 2, 3, 6, 7, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 28, 29, 30, 31, 34, 35, 38, 39, 40, and 41.

Table 4.2a indicates that there are no significant differences among the three groups' average responses in the questions 2, 3, 7, 10, 11, 12, 13, 18, 19, 20, 21, 29, 34, 35 (see Table 4.2a). Also, Table 4.2a indicates that there are significant differences in the answers to questions 1, 6, 14, 15, 22, 23, 28, 30, 31, 38, 39, 40, and 41. Table 4.2b further indicates the differences among the three groups.

In this question set, the reliability coefficient of 304 subjects responses is $\alpha=0.8371$. The reliability coefficients of the three individual groups are :

Group G1 is $\alpha=0.8190$, group G2 is $\alpha=0.8293$, and group G3 is $\alpha=0.8049$.

There are two tables in this section: Table 4.3.1a, testing similarities of group's responses, and Table 4.3.1b testing differences of groups' responses.

Table 4.3.1a Students' attitudinal similarities regarding learning ability

Question	$F_{observed}$ $F_{critical}$=3.04	Question	$F_{observed}$ $F_{critical}$=3.04	Question	$F_{observed}$ $F_{critical}$=3.04
Q 2	1.6604	**Q 12**	0.6539	**Q 20**	1.8337
Q 3	1.3195	**Q 13**	0.0529	**Q 21**	0.7085
Q 7	1.0437	**Q 18**	1.9168	**Q 29**	2.0887
Q 10	0.5599	**Q 19**	2.8743	**Q 34**	0.1825
Q 11	0.7990			**Q 35**	0.8971

Notes:

The results in Table 4.3.1a are selected from Table 4.2a using F-test (ANOVA, Bonferroni, see Table 4.2a). Table 4.2a indicates that there are no significant differences among the three groups' average responses in questions 2, 3, 7, 10, 11, 12, 13, 18, 19, 20, 21, 29, 34, 35 (see Table 4.2a).

In this table, degrees of freedom are df_B=2, df_W=301. The decision of attitudinal similarities are made in significance level of 95% ($\alpha = 0.05$).

In Table 4.3.1a, t-critical values are greater than their t-observed values in all questions. The decisions in these questions are that there are no significant differences among the three groups' responses ($p < 0.05$).

Table 4.3.1b Students' attitudinal differences regarding learning ability

Questions	G1(177) and G2(97) $t_{critical}$ = 1.96	G1(177) and G3(30) $t_{critical}$ = 1.96	G2(97) and G3(30) $t_{critical}$ = 1.96
Q 1	t_{ob}=-2.09 *	t_{ob} =-2.53 *	t_{ob} =-1.11
Q 6	t_{ob} =-1.27	t_{ob} =-2.63 *	t_{ob} =-1.52

Q 14	t_{ob} =-3.18 *	t_{ob} =-2.93 *	t_{ob} =-0.71
Q 15	t_{ob} =-2.83 *	t_{ob} =-2.19 *	t_{ob} =-0.30
Q 22	t_{ob} =-5.26 *	t_{ob} =-7.83 *	t_{ob} =-3.74 *
Q 23	t_{ob} =-6.30 *	t_{ob} =-9.83 *	t_{ob} =-4.93 *
Q 28	t_{ob} =-2.60 *	t_{ob} =-2.70 *	t_{ob} =-1.01
Q 30	t_{ob} =0.35	t_{ob} =-2.74 *	t_{ob} =-3.05 *
Q 31	t_{ob} =0.91	t_{ob} =-2.46 *	t_{ob} =-3.02 *
Q 38	t_{ob} =-3.27 *	t_{ob} =-4.28 *	t_{ob} =-2.01 *
Q 39	t_{ob} =-2.93 *	t_{ob} =-4.56 *	t_{ob} =-3.11 *
Q 40	t_{ob} =-1.69	t_{ob} =-4.23 *	t_{ob} =-3.17 *
Q 41	t_{ob} =-2.76 *	t_{ob} =-4.11 *	t_{ob} =-2.54 *

Notes:

- * $p < 0.05$, the level of significant is $\alpha = 0.05$.
- Table 4.3.1b is formed using results from Table 4.2b.
- Table 4.2a indicates that there are significant differences in the three groups' responses to questions 1, 6, 14, 15, 22, 23, 28, 30, 31, 38, 39, 40, 41. Table 4.2b further indicates differences among the three groups.

1. Comparing group G1 and G2, their t-observed value is greater than their t-critical value in questions 1, 14, 15, 22, 23, 28, 38, 39, and 41. Therefore, there are significant differences between group G1 and G2 in these questions.

2. Comparing group G1 and G3, their t-observed value is greater than their t-critical value in all questions in this table. Therefore, there are significant differences between group G1 and G3 in all questions in Table 4.3.2b.

Comparing group G2 and G3, their t-observed value is greater than their t-critical value in questions 22, 23, 30, 31, 38, 39, 40 and 41. Therefore, there are significant differences between group G2 and G3 in these questions.

4.3.2 Aspect two: Students' attitudes regarding mathematical learning enthusiasm

The question set regarding learning enthusiasm contains questions numbered 4, 5, 6, 7, 8, 9, 10, 11, 16, 17, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 37, 40, 41, 42, 43, 44, 45, 46, 47 and 50.

Table 4.2a indicates that there are no significant differences among the three groups' average responses in questions 4, 7, 8, 9, 10, 11, 16, 17, 24, 25, 29, 44, 45, 46, 47. Also, this Table indicates that there are significant differences in the three groups' responses to questions 5, 6, 22, 23, 26, 27, 28, 30, 31, 37, 40, 41, 42, 43, and 50.

In this question set, the reliability coefficient of 304 subjects' responses is α=0.8260. The reliability coefficients of the three individual groups are:

Group G1, α=0.7908; group G2, α=0.8377; and group G3, α=0.8007.

There are two tables in this section: Table 4.3.2a testing similarities of group's responses and Table 4.3.2b testing differences of groups' responses.

Table 4.3.2a Attitudinal similarities regarding learning enthusiasm

Question	$F_{observed}$ $F_{critical}$=3.04	Question	$F_{observed}$ $F_{critical}$=3.04	Question	$F_{observed}$ $F_{critical}$=3.04
Q 4	1.1643	**Q 11**	0.7990	**Q 29**	2.0887
Q 7	1.0437	**Q 16**	1.9183	**Q 44**	1.0652
Q 8	0.9947	**Q 17**	3.0773	**Q 45**	1.9086

Q 9	0.0838	**Q 24**	0.8316	**Q 46**	1.6131
Q 10	0.5599	**Q 25**	0.6243	**Q 47**	1.6722

Notes:

- Results in Table 4.3.2a are selected from Table 4.2a using F-test (ANOVA, Bonferroni, see Table 4.2a). Table 4.2a indicates that there are no significant difference among the three groups' average responses in questions 4, 7, 8, 9, 10, 11, 16, 17, 24, 25, 29, 44, 45, 46, and 47.
- In this table, the degrees of freedom are **df_B=2, df_W=301**. The decision of attitudinal similarities are made at the 95% level of significance ($\alpha = 0.05$).
- In Table 4.3.2a, t-critical values of all questions are greater than their t-observed values at significant level of $\alpha=0.05$. The decisions in these questions are that there are no significant differences among the three groups' responses ($p < 0.05$).

Table 4.3.2b Attitudinal difference regarding learning enthusiasm

Results / Questions	**G1**(177) **and G2**(97) $t_{critical}$ = 1.96	**G1**(177) **and G3**(30) $t_{critical}$ =1.96	**G2**(97) **and G3**(30) $t_{critical}$ =1.96
Q 5	t_{ob}=2.41 *	t_{ob} =3.09 *	t_{ob} =1.23
Q 6	t_{ob} =-1.27	t_{ob} =-2.63 *	t_{ob} =-1.52
Q 22	t_{ob} =-5.26 *	t_{ob} =-7.83 *	t_{ob} =-3.74 *
Q 23	t_{ob} =-6.30 *	t_{ob} =-9.83 *	t_{ob} =-4.93 *
Q 26	t_{ob} =0.25	t_{ob} =-2.66 *	t_{ob} =-2.48 *
Q 27	t_{ob} =-0.20	t_{ob} =-3.11 *	t_{ob} =-2.65 *
Q 28	t_{ob} =-2.60 *	t_{ob} =-2.70 *	t_{ob} =-1.01

Q 30	t_{ob} =0.35	t_{ob} =-2.74 *	t_{ob} =-3.05 *
Q 31	t_{ob} =0.91	t_{ob} =-2.46 *	t_{ob} =-3.02 *
Q 37	t_{ob} =-2.27 *	t_{ob} =-4.16 *	t_{ob} =-2.94 *
Q 40	t_{ob} =-1.69	t_{ob} =-4.23 *	t_{ob} =-3.17 *
Q 41	t_{ob} =-2.76 *	t_{ob} =-4.11 *	t_{ob} =-2.54 *
Q 42	t_{ob} =-0.36	t_{ob} =-2.67 *	t_{ob} =-2.35 *
Q 43	t_{ob} =-2.70 *	t_{ob} =-3.09 *	t_{ob} =-1.45
Q 50	t_{ob} =-3.09 *	t_{ob} =-2.77 *	t_{ob} =-0.78

Notes:

- Table 4.3.2b is formed using data results from Table 4.2b.
- Comparing groups G1 and G2, their t-observed values were greater than their t-critical values in questions 5, 22, 23, 28, 37, 41, 43 and 50. Therefore, there are significant differences between groups G1 and G2 in these questions.
- Comparing groups G1 and G3, their t-observed values were greater than their t-critical values in all questions in this table. Therefore, there are significant differences between groups G1 and G3 in all questions in Table 4.3.2b.
- Comparing groups G2 and G3, their t-observed values are greater than their t-critical values in questions 22, 23, 26, 27, 30, 31, 37, 40, 41 and 42. Therefore, there are significant differences between groups G2 and G3 in these questions.

4.3.3 Aspect three: Students' attitudes regarding mathematical learning endeavour

The question set regarding learning enthusiasm contains the questions numbered 1, 2, 3, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 24, 25, 26,27, 30, 31, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 46, 47, 48 and 49.

Table 4.2a indicates that there are no significant differences among the three groups' average responses in questions 2, 3, 7, 8, 9, 12, 13, 16, 17, 18, 19, 20, 21, 24, 25, 32, 33, 34, 35, 36, 46, 47, 48, and 49. Also, Table 4.2a indicates that there are significant differences in the answers to questions 1, 6, 14, 15, 26, 27, 30, 31, 38, 39, 40, 41, 42 and 43.

In this question set, the reliability coefficient of 304 subjects' responses is α=0.8234. The reliability coefficients of the three individual groups are :

Group G1, α=0.7721; group G2, α=0.8372; and group G3, α=0.8116.

There are two tables in this section: Table 4.3.3a testing similarities of groups' responses, and Table 4.3.3b testing differences of groups' responses.

Table 4.3.3a Students' attitudinal similarities regarding learning endeavour

Question	$F_{observed}$ $F_{critical}$=3.04	Question	$F_{observed}$ $F_{critical}$=3.04	Question	$F_{observed}$ $F_{critical}$=3.04
Q 2	1.6604	**Q 17**	3.0773	**Q 33**	1.6613
Q 3	1.3195	**Q 18**	1.9168	**Q 34**	0.1825
Q 7	1.0437	**Q 19**	2.8743	**Q 35**	0.8971
Q 8	0.9947	**Q 20**	1.8337	**Q 36**	1.4533
Q 9	0.0838	**Q 21**	0.7085	**Q 46**	1.6131
Q 12	0.6539	**Q 24**	0.8316	**Q 47**	1.6722
Q 13	0.0529	**Q 25**	0.6243	**Q 48**	0.7819
Q 16	1.9183	**Q 32**	1.5689	**Q 49**	1.0002

Notes:

- The results in Table 4.3.3a are selected from Table 4.2a using F-test (ANOVA, Bonferroni, see Table 4.2a). Table 4.2a indicates that there are no significant differences among the three groups' average responses in questions 2, 3, 7, 8, 9, 12, 13, 16, 17, 18, 19, 20, 21, 24, 25, 32, 33, 34, 35, 36, 46, 47, 48, and 49.

- In this table, the degrees of freedom are **df_B=2, df_W=301**. The decision of attitudinal similarities are made at significance level of Alpha $\alpha = 0.05$.

- In Table 4.3.1a, t-critical values are greater than their t-observed values in all questions. The decisions in these questions are that there are no significant difference among the three groups' responses ($p < 0.05$).

Table 4.3.3b Students' attitudinal differences regarding learning endeavour

Results / Questions	**G1**(177) **and G2**(97) $t_{critical}$ = 1.96	**G1**(177) **and G3**(30) $t_{critical}$ =1.96	**G2**(97) **and G3**(30) $t_{critical}$ =1.96
Q 1	t_{ob} =-2.09 *	t_{ob} =-2.53 *	t_{ob} =-1.11
Q 6	t_{ob} =-1.27	t_{ob} =-2.63 *	t_{ob} =-1.52
Q 14	t_{ob} =-3.18 *	t_{ob} =-2.93 *	t_{ob} =-0.71
Q 15	t_{ob} =-2.83 *	t_{ob} =-2.19 *	t_{ob} =-0.30
Q 26	t_{ob} =0.25	t_{ob} =-2.66 *	t_{ob} =-2.48 *
Q 27	t_{ob} =-0.20	t_{ob} =-3.11 *	t_{ob} =-2.65 *
Q 30	t_{ob} =0.35	t_{ob} =-2.74 *	t_{ob} =-3.05 *
Q 31	t_{ob} =0.91	t_{ob} =-2.46 *	t_{ob} =-3.02 *

Q 38	t_{ob} =-3.27 *	t_{ob} =-4.28 *	t_{ob} =-2.01 *
Q 39	t_{ob} =-2.93 *	t_{ob} =-4.56 *	t_{ob} =-3.11 *
Q 40	t_{ob} =-1.69	t_{ob} =-4.23 *	t_{ob} =-3.17 *
Q 41	t_{ob} =-2.76 *	t_{ob} =-4.11 *	t_{ob} =-2.54 *
Q 42	t_{ob} =-0.36	t_{ob} =-2.67 *	t_{ob} =-2.35 *
Q 43	t_{ob} =-2.70 *	t_{ob} =-3.09 *	t_{ob} =-1.45

Notes:

- Table 4.3.1b is formed using results from Table 4.2b.
- Table 4.2a indicates that there are significant differences in the groups' responses to questions 1, 6, 14, 15, 26, 27, 30, 31, 38, 39, 40, 41, 42, and 43. Table 4.2b further indicates differences among the three groups.
- Comparing groups G1 and G2, their t-observed values were greater than their t-critical values in questions 1, 14, 15, 38, 39, 41 and 43. Therefore, there are significant differences between groups G1 and G2 in these questions.
- Comparing groups G1 and G3, their t-observed values are greater than their t-critical values in all questions in this table. Therefore, there are significant differences between groups G1 and G3 in all questions in Table 4.3.3b.
- Comparing groups G2 and G3, their t-observed values were greater than their t-critical values in questions 26, 27, 30, 31, 38, 39, 40, 41 and 42. Therefore, there are significant differences between groups G2 and G3 in these questions.

The results presented in this chapter are interpreted in the next chapter.

Chapter 5 Data Interpretation

The numerical results from the statistical analysis presented in Chapter 4 are interpreted in this Chapter, in order to make clear the student perspectives on the several research questions. To restore the original meanings of the collected data, the project took two approaches to the data interpretation. The first approach was to the interpretation which must return the numerical scale and data results to original meanings of each numerical scale in the main questionnaire. The second approach is of ample implications which means the data interpretation must explain and indicate the whole meaning of the data results with both connotation and extension.

In the first instance, the data has been interpreted according to the suggestions of Klausmeier (1985) who indicated that attitudes have a (i) cognitive component, (ii) an affective component and (iii) a learned component. Consequently, the study focuses on the following analyses, which are discussed in detail in this Chapter:

- Attitudinal comparison regarding mathematical learning ability, including attitudinal differences and similarities ('Cognitive')

- Attitudinal comparison regarding mathematical learning enthusiasm, including attitudinal differences and similarities ('Affective')

- Attitudinal comparison regarding mathematical learning endeavour, including attitudinal differences and similarities ('Learned')

For each focus area, the differences and similarities among the three target groups are displayed and discussed.

5.1 Attitudinal comparisons regarding mathematical learning ability (the 'cognitive' component)

5.1.0 Introduction

In the literature review regarding students' attitudes and learning abilities (see Chapter 2), students' attitudes towards learning abilities are associated with a number of effective and affective factors including self-concept, self-assessment, peer influences, previous learning experiences, and personal interests. This project was an attempt to clarify cross-cultural influences and related effective and affective factors regarding innate and demonstrated ability within school and university mathematics courses in different countries, with particular reference to Asian countries, via a student's perspective. Specifically, the project tried to identify answers to the following questions:

- Do students' attitudes towards innate ability and demonstrated ability differ in students who have different family backgrounds, or who have studied final year of secondary mathematics in a different country ?

- What is the nature of these attitudinal differences or similarities between the target groups for the above question?

Results from section 4.3.1 indicate that both attitudinal similarities and differences towards mathematics learning abilities coexist in the three student groups (G1, G2, G3). Whilst in some questions, the average responses from the three groups were shown to be not significantly different, other questions showed significant differences. For example, significant attitudinal differences towards mathematics learning abilities occurred in questions relating to:

- Learning ability and poor mathematical results (Q 14, 15)

- Learning ability and confidence in learning university mathematics (Q 28)

- Learning ability and mathematical graphs and charts (Q 30, 31)

- Learning ability and mathematical learning strategies (Q 38, 39)

Analysis for this component are presented in the following sections using the four permutations of comparison for the three test groups (G1, G2, G3):

Section 5.1.1 shows attitudinal differences between groups G1 and G2;

Section 5.1.2 shows attitudinal differences between groups G1 and G3;

Section 5.1.3 shows attitudinal differences between groups G2 and G3;

Section 5.1.4 shows attitudinal similarities in the three test groups.

5.1.1 Attitudinal difference regarding learning abilities between groups G1 and G2

The results in Chapter 4 (Table 4.3.1b) indicate that there are significant attitudinal differences between G1 and G2 in questions that are related to learning ability and:

- mathematical learning performance (Q1)
- assessment of university mathematics courses (Q41)
- learning strategies (Q38, 39)
- poor mathematical results (Q14, 15)
- mathematical enjoyment (Q22, 23)
- confidence in learning university mathematics (Q28)

There are no significant attitudinal differences between G1 and G2 in questions that are related to learning ability and:

- the importance of learning school mathematics (Q6)
- mathematical graphs and charts (Q30, 31)

- assessment of school mathematics (Q40)

The average responses by all students in groups G1 and G2 to the above questions are shown in Figure 5.1.1, which illustrates the attitudinal differences between groups G1 and G2.

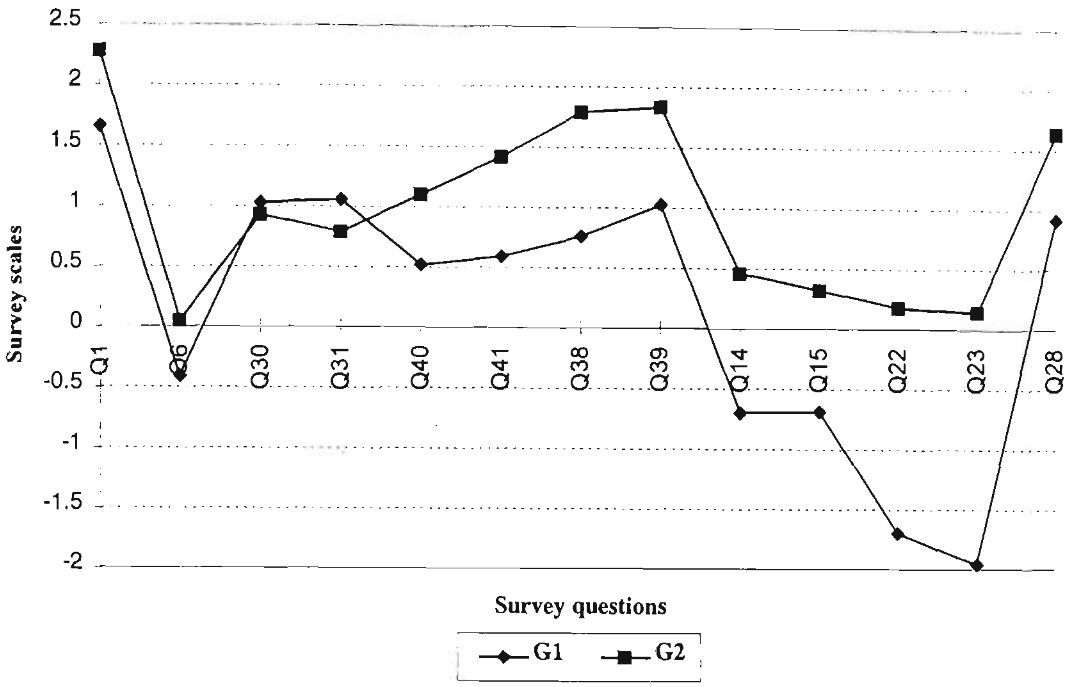


Figure 5.1.1 Attitudinal differences regarding learning abilities between groups G1 and G2

Figure 5.1.1 indicates that both attitudinal similarities and differences occurred between groups G1 and G2. As has been indicated in Chapter 4, group G1 consisted of students who were born and studied year 12 in Australia. Group G2 consisted of students who were born in countries other than Australia, but who studied year 12 in Australia.

Attitudinal similarities between G1 and G2 appeared in questions regarding learning abilities specifically related to calculations, using graphs and charts, and mathematical performance. For example, both groups G1 and G2 believed that students who perform well in mathematics at school will perform well in mathematics at university (Q1). Also, both G1 and G2 slightly agreed that graphs and charts help people understand school and university mathematical ideas (Q30, 31). However, both G1 and G2 were uncertain whether or not the main reason they studied mathematics at school was to learn how to do calculations (Q6).

These results imply that, for groups G1 and G2, attitudes towards learning ability related to calculations, graphs and charts, are not affected by their year 12 schooling or their family backgrounds.

By contrast, differences in attitudes between groups G1 and G2 students appeared in questions regarding the link between general learning abilities and (i) assessment methods, (ii) learning strategies, (iii) poor mathematical learning results, (iv) enjoyment of mathematics, and (v) confidence toward learning university mathematics.

Regarding the link between general learning ability and assessment methods or learning strategies which the students employed, responses from G2 indicate that they were confident in the way that they adjusted themselves to course organisation and assessment in school and university courses, and also in the learning strategies which they were able to use in their mathematics study (Q28, 38, 39, 41). However, responses relating to the same items from G1 showed that they were much more uncertain. For example, G1 students were uncertain as to whether the organisation and assessment of mathematics courses in school and university were helpful for their learning (Q38, 39 40, 41).

Whereas both G1 and G2 did not either strongly attribute or deny that poor learning ability led to poor learning results, there was a significant difference in the direction of the responses, G1 tending to deny the link, whilst G2 tended to affirm the link (Q 14, 15). With regard to the items relating to mathematical enjoyment, group G1 strongly disagreed that mathematics brought enjoyment to their lives, whilst group G2 were uncertain (Q22, 23).

For these items which showed significant attitudinal difference between the groups it appears that, since both G1 and G2 studied their year 12 in Australia and their learning content and materials in secondary school were based on Australian educational requirement, these differences most likely arose from parental values and family backgrounds.

5.1.2 Attitudinal differences regarding learning abilities between groups G1 and G3

The results in Chapter 4 (Table 4.3.1b) indicate that there are significant attitudinal differences between G1 and G3 in questions which are related to learning ability and:

- mathematical learning performance (Q1)
- the importance of learning school mathematics (Q6)
- mathematical graphs and charts (Q30, 31)
- assessment of school and university mathematics (Q40, 41)
- learning strategies (Q38, 39)
- poor mathematical results (Q14, 15)
- mathematical enjoyment (Q22, 23)
- confidence in learning university mathematics (Q28)

The average responses by all students in groups G1 and G3 to the above questions are shown in Figure 5.1.2 which illustrates the attitudinal differences between groups G1 and G3.

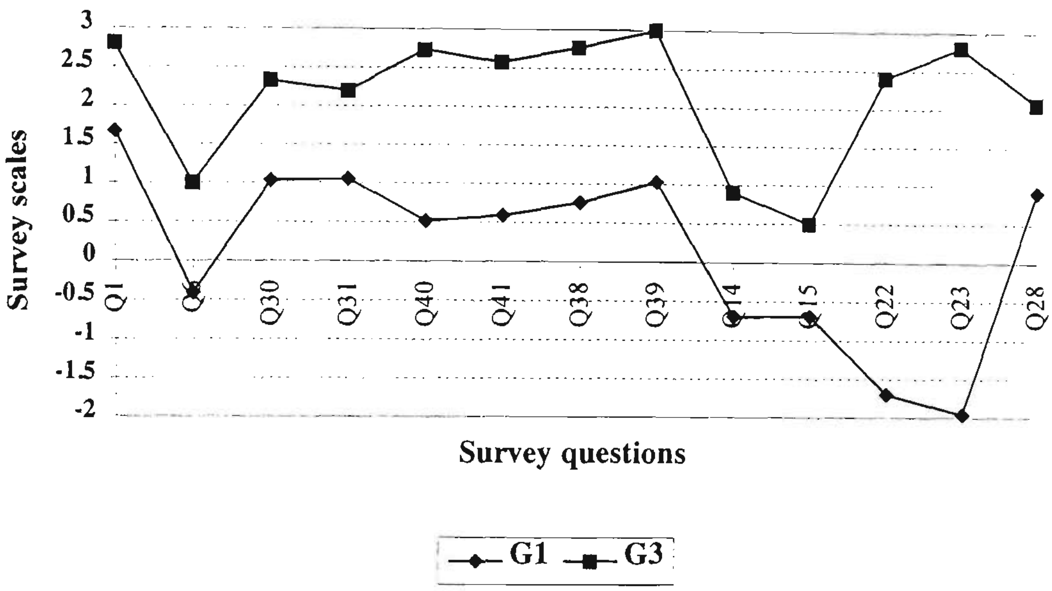


Figure 5.1.2 Attitudinal differences regarding learning abilities between groups G1 and G3

Figure 5.1.2 indicates that attitudinal differences occurred between groups G1 and G3. As has been indicated in Chapter 4, group G1 consisted of students who were born, and studied year 12, in Australia. Group G3 consisted of students who were born in Asia and studied final year secondary schools in Asia.

First, attitudinal differences between G1 and G3 appeared in questions regarding the link between learning abilities and (i) previous mathematical performance, (ii) capacity of using calculation, graphs, and (iii) learning strategies. Group G3 believed, more strongly than group G1, that students who perform well in mathematics at school will perform well in mathematics at university (Q1). G3 responses indicated that the concept of good performance is more likely related to abilities of using graphs than calculation (Q6, 30, 31). Also, G3's responses more positively indicated than group G1 that they felt confident in accepting and adjusting to mathematical course assessment and strategies (Q40, 41, 38, 39). In these questions G1's attitudes were more hesitant and uncertain.

These results imply that previous learning experiences do affect students' attitudes towards their general learning ability and the way they learn. Asian background students are more likely to link their general learning ability to the ability of learning methods and mastery of learning strategies. Also Asian background students paid more attention in using graphs rather than using calculation, to help their mathematical learning, as well as learning strategies.

Secondly, attitudinal differences between groups G1 and G3 appeared in questions regarding the link between general learning abilities and (i) poor mathematical learning results, (ii) mathematical learning enjoyment and (iii) mathematical learning confidence (Q14, 15, 22, 23, 28). Whereas both G1 and G3 did not either strongly attribute or deny that poor learning results lead to poor learning ability, there was a significant difference in the direction of the responses with G1 tending to deny the link, whilst G3 tended to affirm the link (Q14, 15). However, both G1 and G3 indicated that they felt confident in their learning ability and they believed that they can do well in university mathematics (Q28). With regard to the items relating to mathematical enjoyment, G3's responses very positively indicated that mathematics brought enjoyment to their lives (Q22, 23). Oppositely, G1 did not agree that mathematics they did at school and university brought enjoyment to their life (Q22, 23). These results imply that differences of students' family backgrounds and differences in students' previous learning environment did not significantly affect students' confidence in their innate learning ability. However, the results relating to the items of mathematical enjoyment imply that Asian background students derived mathematical enjoyment from their mathematical learning.

5.1.3 Attitudinal differences regarding learning abilities between groups G2 and G3

The results in Chapter 4 (Table 4.3.1b) indicate that there are significant attitudinal differences between G2 and G3 in questions which are related to learning ability and:

- mathematical graphs and charts (Q30, 31)

- learning strategies (Q38, 39)
- assessment of school and university mathematics (Q40, 41)
- mathematical enjoyment (Q22, 23)

There are no significant attitudinal differences between G2 and G3 to questions which are related to learning ability and:

- confidence in learning university mathematics (Q28)
- mathematical learning perform (Q1)
- poor mathematical results (Q14, 15)
- the importance of learning school mathematics (Q6)

The average responses by all students in groups G2 and G3 to the above questions are shown in Figure 5.1.3, which illustrates the attitudinal differences between groups G2 and G3.

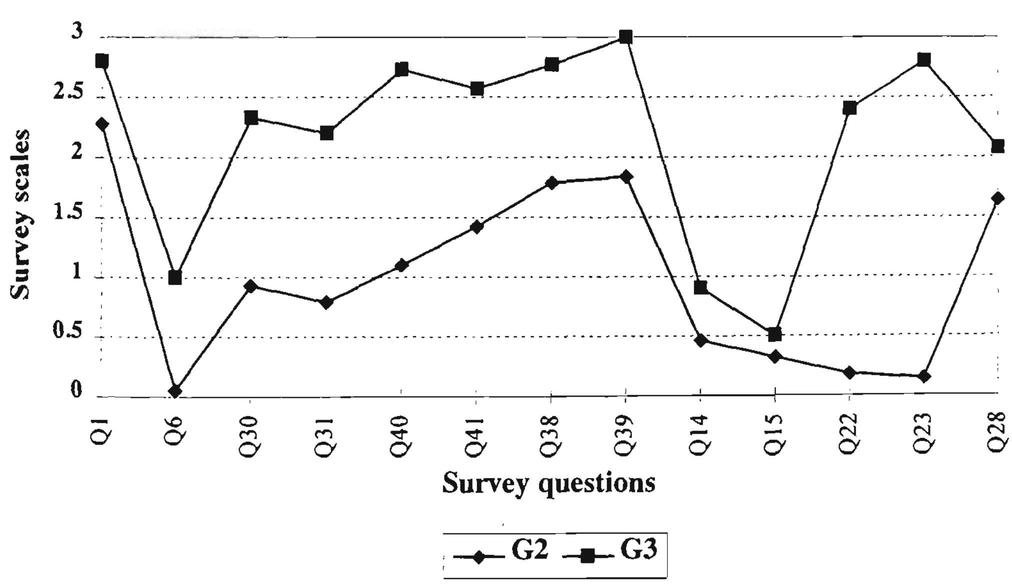


Figure 5.1.3 Attitudinal differences regarding learning abilities between groups G2 and G3

Figure 5.1.3 indicates that both attitudinal similarities and differences occurred between groups G2 and G3. As has been indicated in Chapter 4, Group G2 consisted of students who were born in countries other than Australia, but who studied year 12 in Australia. Group G3 consisted of students who were born in Asia and studied final year secondary in schools in Asian countries.

Attitudinal similarities between G2 and G3 appeared in questions regarding the link between general learning abilities and (i) learning confidence, (ii) learning performance and (iii) poor learning results. Both groups G2 and G3 believed that they felt confident of doing well in university mathematics (Q28). They also believed that the ability to do well in university mathematics might be affected through previous learning performance (Q1). Both G2 and G3 did not strongly attribute that poor learning ability led to poor learning results. However, both G2 and G3 tended to affirm this link (Q14, 15). For example, both G2 and G3 were uncertain about the link between the importance of calculation ability and the learning outcomes in school mathematics (Q6). These results imply that the differences in students' previous learning environments and school experiences did not affect students' beliefs in their learning ability or their self-esteem.

By contrast, attitudinal differences between groups G2 and G3 appeared in questions regarding the link between general learning abilities and (i) the ability to interpret mathematical graphs and charts, (ii) learning strategies and assessment, and (iii) mathematical learning enjoyment. These attitudinal differences were apparent in the different levels of agreement shown by each group. In comparison with G2, G3 more positively indicated that the ability of using graphs and charts in university mathematics were more helpful and important than calculation (Q6, 30, 31). Both G2 and G3 indicated the importance of abilities related to learning strategies (Q38, 39). They believed that organisation and assessment of the mathematics course in school and university were helpful for their learning (Q40, 41).

Particularly, G2 and G3 indicated a significant attitudinal difference in mathematical enjoyment (Q22, 23). G2 did not indicate that they found mathematical enjoyment (Q22, 23). However, G3 strongly agree that the mathematics they did at school and university brought enjoyment to their life (Q22, 23).

These results imply that the differences in students' previous learning environments and school experiences did affect students' attitudes towards their learning methods and the way of learning, as well as mathematical enjoyment.

5.1.4 Attitudinal similarities regarding mathematical learning ability among the three groups (G1, G2, G3)

The results in Chapter 4 (Table 4.3.1a) indicate that there are no significant attitudinal differences in the three target groups in questions which are related to learning ability and:

- the importance of problem-solving ability (Q10, 11)
- the importance of memory (Q20, 21)
- memory and calculation (Q34, 35, 7)
- concept of mathematical intelligence (Q2, 3)
- good mathematical results and learning ability (Q12, 13)
- confidence of learning school mathematics (Q29)
- effects between ability and effort (Q18, 19)

The average responses by all three target groups (G1, G2, G3) to the above questions are shown in Figure 5.1.4, which illustrates the attitudinal similarities among the three target groups G1, G2 and G3.

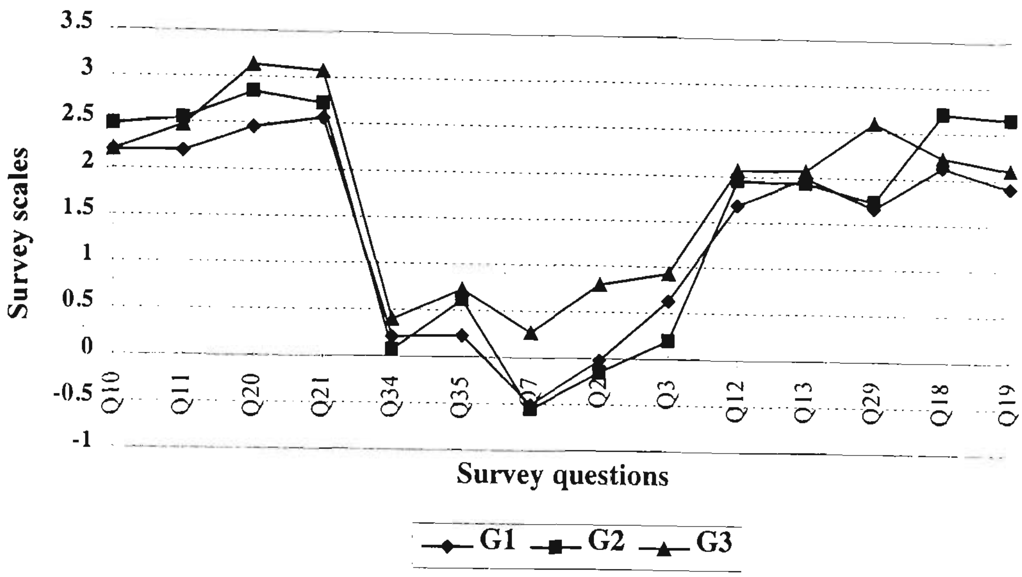


Figure 5.1.4 Attitudinal similarities regarding learning abilities among G1, G2, and G3

Figure 5.1.4 indicates that attitudinal similarities regarding learning ability occurred in the three groups G1, G2, and G3.

First, attitudinal similarities among G1, G2, and G3 appeared in questions regarding the link between general learning ability and (i) abilities of problem-solving, (ii) memory, and (iii) calculation. All three groups believed that problem-solving ability and good memory are very important for getting good mathematics results at school and university (Q10, 11, 20, 21). The ability of memory was slightly, but not significantly, emphasised more by G3 than problem-solving ability (Q20, 21).

However, though the ability of memory was slightly emphasised by G3 (Q20, 21), the three groups were uncertain whether or not university mathematics is mainly learnt by memorising rules and formulae (Q35, 34). Also, the three groups were uncertain whether or not the main reason they study mathematics at university was to do calculations (Q7).

Consequently, the link between the concepts of mathematical intelligence and learning ability were uncertain (Q2, 3) in that the three groups were uncertain whether or not people who are good at school and university mathematics are intelligent (Q2, 3). While innate ability is emphasised by the three groups, they also recognised the importance of learning effort. Three groups believed that when they do poorly in mathematics at school and university, it was because of their lack of effort (Q18, 19). Also, the three groups believed that when they did well in mathematics at school and at university, it was because of their own ability (Q13, 12). They felt confident of doing well in mathematics at school (Q29), since good learning results come from not only good learning ability, but also from learning effort.

These results imply that the differences in family backgrounds and previous learning environment in different countries did not affect students' attitudes towards their innate learning ability, such as the ability of problem solving and memory. Also, cultural differences did not provide the attitudinal differences regarding learning effort. All students understood that good mathematical learning results not only come from good innate ability, such as memory, but also come from sufficient learning effort. Section 5.3 shows the three target groups' different responses to questions regarding learning effort and their mathematical learning.

5.2 Attitudinal comparison regarding mathematical learning enthusiasm (the 'affective' component)

5.2.0 Introduction

In the literature review regarding students' attitudes and enthusiasm to mathematics learning (see Chapter 2), students' attitudes towards learning enthusiasm are associated with a number of effective and affective factors, including encouragement, motivation, parental value, career interests, previous learning experiences and ideas of mathematical enjoyment. This project was an attempt to clarify cross-cultural influences and related effective and affective factors regarding intrinsic drive and extrinsic drive within school and university mathematics courses in different countries, with particular reference to Asian countries, via a students' perspective. Specifically, the project tried to identify answers to the following questions:

- Does the enthusiasm towards mathematics learning differ in students who have different family backgrounds or who have studied final year of secondary mathematics in different countries ?
- Where are the nature of these attitudinal differences or similarities between the target groups for the above questions ?

Results from section 4.3.2 indicate that both attitudinal similarities and differences towards their emotional perception of mathematics learning coexist in the three student groups (G1, G2, G3). Whilst in some questions, average responses from the three groups were shown not to be significantly different (Section 5.2.4), other questions showed significant differences. For example, significant attitudinal differences towards mathematics learning enthusiasm occurred in questions relating to learning enthusiasm and:

- the importance for future jobs (Q5)
- calculations (Q6)

- the enjoyment of mathematics learning (Q37, 22, 23)
- peer and parental influences (Q26, 27, 50)
- confidence (Q28)

Results for this component are presented in following sections using the four permutations of comparison for the three test groups (G1, G2, G3):
Section 5.2.1 shows attitudinal differences between groups G1 and G2;
Section 5.2.2 shows attitudinal differences between groups G1 and G3;
Section 5.2.3 shows attitudinal differences between groups G2 and G3.
Section 5.2.4 shows attitudinal similarities in the three test groups.

5.2.1 Attitudinal differences regarding learning enthusiasm between groups G1 and G2

The results in Chapter 4 (see Table 4.3.2b) show there are significant attitudinal differences between G1 and G2 to questions which are related to learning enthusiasm and:

- the importance for future jobs (Q5)
- mathematical enjoyment (Q22, 23)
- confidence in learning university mathematics (Q28)
- mathematical enjoyment (Q37)
- assessment of university mathematics course (Q41)
- the ways mathematics was taught in university (Q43)
- parental interests (Q50)

There are no significant attitudinal differences between G1 and G2 in questions which are related to:

- calculation in school mathematics (Q6)
- peer influences (Q26, 27)
- mathematical graphs and charts (Q30, 31)
- assessment of school mathematics (Q40)
- the ways mathematics was taught in school (Q42)

The average responses by all students in groups G1 and G2 to the above questions are shown in Figure 5.2.1, which illustrates the attitudinal differences between groups G1 and G2.

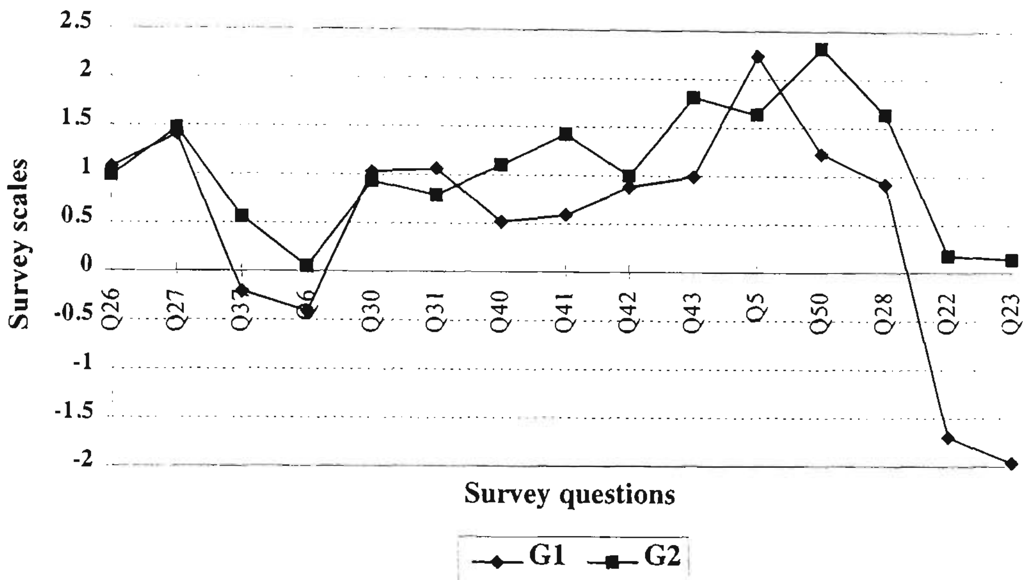


Figure 5.2.1 Attitudinal differences regarding learning enthusiasm between groups G1 and G2

Figure 5.2.1 indicates that both attitudinal similarities and differences occurred between groups G1 and G2. As has been indicated in Chapter 4, group G1 consisted of students who were born, and studied year 12, in Australia. Group G2 consisted of students who were born in countries other than Australia, but who studied year 12 in Australia.

Attitudinal similarities between G1 and G2 appeared in questions regarding learning enthusiasm specifically related to (i) the preference of joining a discussion group, (ii) using calculation, and (iii) assistance of mathematical graphs and charts within school and university mathematics learning.

Both groups G1 and G2 indicated that they preferred to study school and university mathematics by joining small discussion groups (Q26, 27). Comparatively, both groups G1 and G2 indicated that they were more keen to join a discussion group in university than in school (Q26, 27). However, the preference of joining a university discussion group did not imply that students' general feeling about university mathematics is more positive than school mathematics (Q37). Both G1 and G2 did not either strongly agree or deny that university mathematics is more enjoyable than school mathematics (Q37). Referring to the general feeling about calculation and graphs and charts, both G1 and G2 were uncertain of the importance of doing calculation in school mathematics (Q6). Also, both G1 and G2 indicated that they liked the assistance obtained through graphs and charts (Q30, 31).

These items, which showed attitudinal similarities between the groups G1 and G2, imply that the differences in students' family backgrounds did not significantly affect students learning enthusiasm, since G1 and G2 have different family backgrounds. Students' feelings relating to the above items were most likely shaped by school learning experiences, since both G1 and G2 studied their year 12 in Australia, and their learning outcomes were assessed according to Australian educational requirements.

By contrast, differences in attitudes between groups G1 and G2 students appeared in questions regarding the link between general learning enthusiasm and (i) mathematics course assessment, (ii) the way of teaching, and (iii) external influences including future job, parental interest and learning enjoyment.

Regarding the course assessment, G2 was more likely to indicated that they felt that school and university assessment made them work hard through the year, especially the assessment of university mathematics (Q40, 41). However, G1 did not show this for school and university assessment (Q40 and 41), even though both G1 and G2 liked the teaching styles in both school and university (Q42, 43).

Students' responses also indicated that student learning enthusiasm was affected by external influences including the support for future jobs, parental interest and learning enjoyment. Students' feelings about studying mathematics courses were associated with the support for future jobs. They believed that studying school mathematics could provide support for their future job (Q5). Students' feelings about studying mathematics were also associated with parental interests (Q50). Students felt that their parents' interest in their mathematics study made students feel good. Especially, G2 were more concerned whether or not their parents showed an interest in their study (Q50). Also, G1 and G2 implied a parallel relationship between parental concern and students' self-esteem in their university mathematical learning (Q50, 28). G2 were more concerned that their parents pay attention and interest in their study than G1. G2's responses indicated that they were more confident in their university mathematics study than G1 (Q50, 28). However, these external influences did not automatically bring mathematical enjoyment to their life. G2's responses indicated that there were uncertain whether or not mathematics brought enjoyment to their life (Q22, 23). The response from G1 indicated a bored feeling. And G1 indicated that they disagree that mathematics brought enjoyment to their life (Q22, 23).

These results showed that the attitudinal differences between the groups G1 and G2 were most likely derived from students' family backgrounds, since both the differences between G1 and G2 are in their family backgrounds, which might provide a different view of mathematics course assessment, the way of teaching, mathematical courses in support to future jobs, parental interest and learning enjoyment.

5.2.2 Attitudinal differences regarding learning enthusiasm between groups G1 and G3

The results in Chapter 4 (Table 4.3.2b) indicate that there are significant attitudinal differences between G1 and G3 in questions which are related to learning enthusiasm and:

- confidence in learning university mathematics (Q28)
- mathematical graphs and charts (Q30, 31)
- the ways mathematics was taught (Q42, 43)

- peer influences (Q26, 27)
- parental interests (Q50)
- the importance for future jobs (Q5)
- assessment of mathematics courses (Q40, 41)
- calculation in school mathematics (Q6)
- mathematical enjoyment (Q37, 22, 23)

The average responses by all students in groups G1 and G3 to the above questions are shown in Figure 5.2.2, which illustrates the attitudinal differences between group G1 and G3.

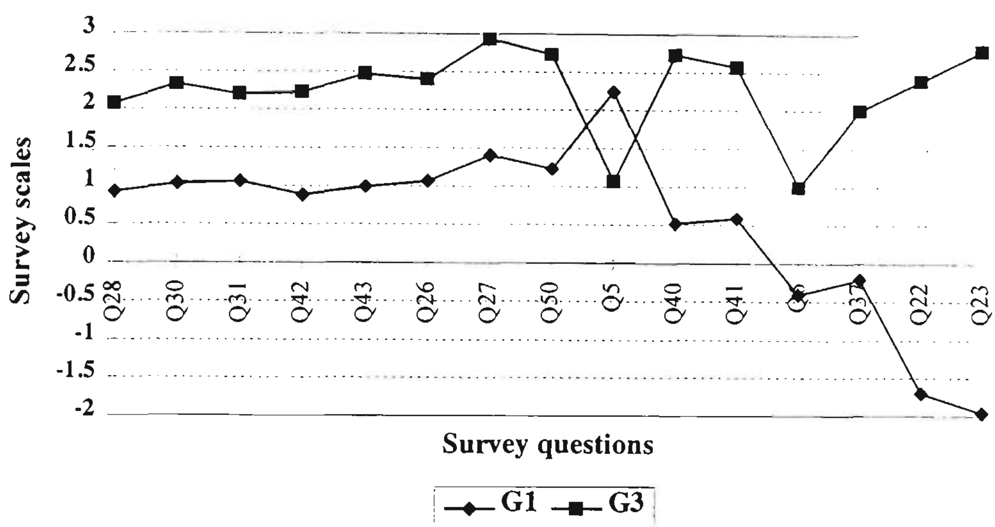


Figure 5.2.2 Attitudinal differences regarding learning enthusiasm between groups G1 and G3

Figure 5.2.2 indicates that attitudinal differences occurred between group G1 and G3. As has been indicated in Chapter 4, group G1 consisted of students who were born, and studied year 12, in Australia. Group G3 consisted of students who were born in Asia and studied final year secondary schools in Asia.

First of all, the differences in attitudes between groups G1 and G3 students appeared in questions relating to the link between learning enthusiasm and (i) confidence in learning achievement, (ii) using graphs and teaching styles, and (iii) peer and parental influences. These attitudinal differences were apparent in the different levels of agreement shown by each group.

Comparing the responses from G1 and G3, G3 more positively indicated that they felt confident of doing well in university mathematics study (Q28). They affirmed that graphs and charts did help them to understand mathematical ideas (Q30, 31). Also, they liked the teaching styles in both school and university (Q42, 43). Regarding the peer and parental influences, G3 more positively indicated their preference of joining discussion groups, and they liked the learning and teaching ways in school and university mathematics learning (Q26, 27). Also, they liked their parents to know what the students were doing (Q50).

However, in the question regarding their school mathematics and their future job, G3's feeling became more negative than G1. G3 did not believe as strongly as G1 that school mathematics could provide support for their future job (Q5). This feeling was more likely derived from their backgrounds. G3 were newcomers in Australia and they completed their secondary school study in Asian countries.

Finally, the differences in attitudes between G1 and G3 students occurred in questions regarding the link between learning enthusiasm and (i) mathematical course assessment, and (ii) learning enjoyment (Q40, 41, 37, 22, 23). In these items, G3 had more positive feelings than G1. G3 indicated that they felt that school and university assessment made them work hard through the year, especially the assessment of university mathematics (Q40, 41). However, G1 did not feel that they could effectively follow the ways of course arrangement and assessment (Q40, 41). G3 felt that they liked university mathematics more than school mathematics (Q37). G2, however, indicated that they did not think university mathematics more enjoyable than school mathematics (Q37). These responses would imply that the classroom and teaching styles in an Australian university were of more appeal to G3 than G1, which might arise from the differences between G3's current learning environment and G3's previous schooling in Asian countries (Q37). In addition, G3's responses indicated that they believed that both school and university mathematics brought enjoyment to their life

(Q22, 23). However, the response from G1 indicated a bored feeling. And they disagreed that mathematics brought enjoyment to their life (Q22, 23).

These positive attitudes of Asian born students might come from co-operative study activities within student groups. Similar results have been indicated by Caplan, Choy and Whitmore (1992). They indicated that Indochinese students honour mutual, collective obligations to one another and to their relatives. The older children help their younger siblings. The younger children, in particular, are taught not only subject matter but how to learn. The familial setting appears to make the children feel at home in school and, consequently, perform well there. Resnick (1990) also indicated the importance of group co-operation and its two functions. One is that it provides occasions for modelling effective thinking strategies and, through observing others, the student has great opportunity to become aware of mental processes that might otherwise remain entirely implicit, thereby improving their own thinking. Another function is for practising thinking skills in a highly motivating manner. Therefore, it is important to identify the different and similar co-operative styles between Australian and Asian students' groups. This identification could provide more useful information and understanding for teaching methods and students' experiences shared at both year 12 and university levels.

Section 5.2.3 Attitudinal differences regarding learning enthusiasm between groups G2 and G3

The results in Chapter 4 (Table 4.3.2b) indicated that there are significantly attitudinal differences between G2 and G3 in questions which are related to learning enthusiasm and:

- assessment of mathematics course (Q40, 41)
- the ways mathematics was taught in school (Q42)
- peer influences (Q26, 27)
- mathematical graphs and charts (Q30, 31)
- mathematical enjoyment (Q22, 23, 37)

There are no significant attitudinal differences between G2 and G3 in questions which are related to learning enthusiasm and:

- confidence in learning university mathematics (Q28)
- the ways mathematics was taught in university (Q43)
- parental interests (Q50)
- the importance for future jobs (Q5)
- calculation in school mathematics (Q6)

The average responses by all students in groups G2 and G3 to the above questions are shown in Figure 5.2.3, which illustrates the attitudinal differences between groups G2 and G3.

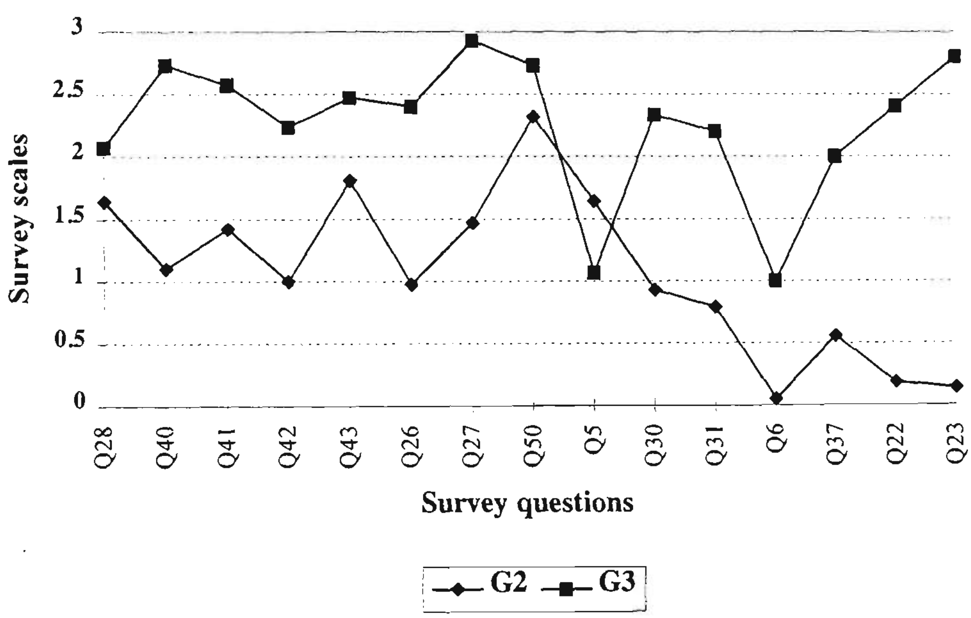


Figure 5.2.3 Attitudinal differences regarding learning enthusiasm between groups G2 and G3

Figure 5.2.3 indicates that both attitudinal similarities and differences occurred between group G2 and G3 in the following questions regarding learning enthusiasm.

Attitudinal differences between G2 and G3 appeared in questions regarding learning enthusiasm specifically related to (i) mathematical course assessment, (ii) teaching styles, and (iii) peer and parental affects. These attitudinal differences between G2 and G3 were apparent in the different levels of agreement shown by each group. G3 agreed more strongly than G2 that school and university assessment made them work hard through the year (Q40, 41). Also, G3 more positively than G2, indicated that they liked the teaching styles in school (Q42). However, there were no significant differences in the items related to (i) their liking of university mathematics and (ii) their learning confidence. Both G2 and G3 positively indicated that (i) they liked the way mathematics was taught in university (Q43), and (ii) they felt confident of doing well in university mathematics study (Q28).

Regarding the peer and parental influences, attitudinal differences appeared in questions related to peer influence, and attitudinal similarities appeared in the item related to parental effect. G3 more positively than G2 indicated their preference of joining discussion group (Q26, 27). And both G2 and G3 indicated that they liked their parents to show an interest in their study (Q50).

These results imply that the differences in school learning environments could enhance students' learning enthusiasm, since G2 and G3 studied their senior high school in Australia and Asian countries. This reinforcement might derive from the peer influences and teaching methods.

However, there were no significant attitudinal differences between G2 and G3 in the question regarding their future job, both slightly believed that studying school mathematics is important for getting a job (Q5). But the response from G3 was slightly more negative than G2 which was similar to the responses between G1 and G3 (see section 5.2.2). This feeling was more likely produced from their backgrounds. G2 completed their secondary study in Australia, but G3 were newcomers to Australia and they completed their secondary school study in Asian countries.

Also, attitudinal differences between G2 and G3 occurred in questions regarding the assistance from graphs and mathematical enjoyment (Q30, 31, 37, 22, 23). In these items, G3 had more positive feelings than G2. G3 indicated that they like to use graphs and charts for helping their study (Q30, 31). G3 felt that they liked university mathematics more than liked school mathematics (Q37). G2's response, however, did not indicate whether or not they like to use graphs and charts for helping their study (Q30, 31). And G2 were uncertain whether university mathematics was more enjoyable than school mathematics (Q37). These responses would imply that the classroom and teaching styles in the Australian university are more interesting than G3's previous schooling in Asian countries (Q37). In addition, G3's responses indicated that they believed that both school and university mathematics brought enjoyment to their life (Q22, 23). However, the response from G2 indicated an uncertain feeling and they were uncertain whether or not school and university mathematics brought enjoyment to their life (Q22, 23). These results imply that students' different responses to their learning enjoyment might derive from their different school learning experiences obtained from Australia and Asian countries.

5.2.4 Attitudinal similarities regarding learning enthusiasm among the three groups (G1, G2, G3)

The results in Chapter 4 (Table 4.3.2a) indicate that there are no significant attitudinal differences among the three groups in the questions which are related to learning enthusiasm and:

- the task difficulty between school and university leaning (Q36)
- preference of learning on one's own (Q24, 25)
- the importance of calculations and problem-solving (Q7, 10, 11)
- preference of mathematics associated with life situation or future job (Q4, 8, 9)
- parental encouragement and expectation of their mathematics learning (Q44, 45, 46, 47)
- good results and hard work (Q16, 17)
- confidence in mathematics learning (Q29)

The average responses by all students in groups G1, G2 and G3 to the above questions are shown in Figure 5.2.4, which illustrates the attitudinal similarities among the three target groups G1, G2, and G3.

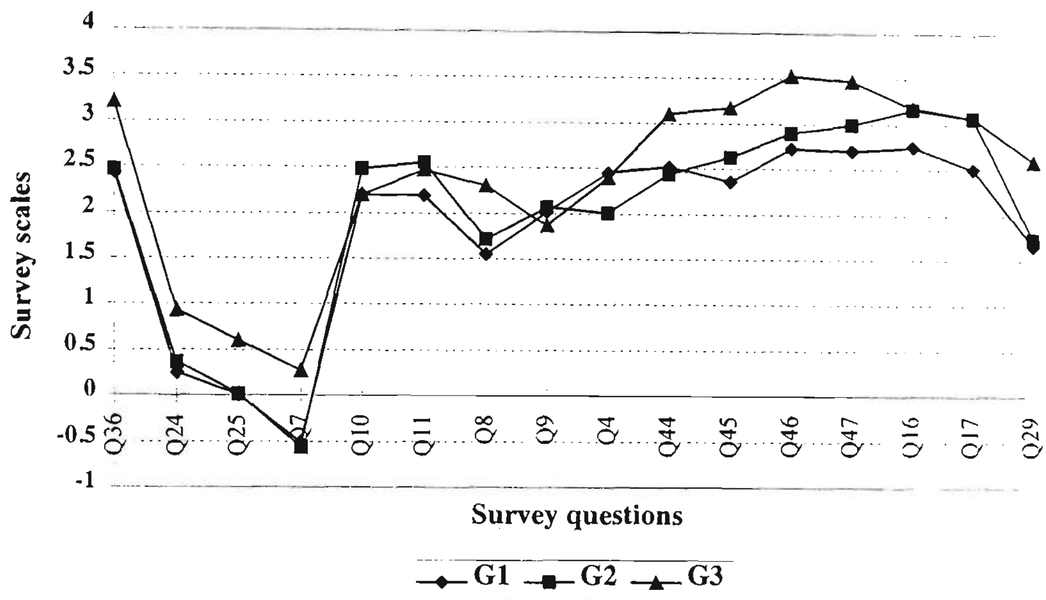


Figure 5.2.4 Attitudinal similarities regarding learning enthusiasm among G1, G2 and G3

Figure 5.2.4 indicates that no significant attitudinal differences occurred in the three target groups (G1, G2, G3) in the above questions.

Attitudinal similarities among the three target groups appeared in questions regarding learning enthusiasm specifically related to (i) students' emotional perception of a new learning environment in university, and (ii) the self-esteem in their own capability. All three groups believed that university mathematics is harder than year 12 mathematics (Q36). In regard to the self capability to adjust to new learning environment, independent study had been weakly emphasised and problem-solving ability had been highly emphasised. All three groups were uncertain whether or not they prefer to do mathematics on their own (Q24, 25). Whilst the importance of calculation is not clearly indicated, all three groups were not sure whether or not the main reason they study mathematics at university is to do calculation (Q7). All three groups believed that problem-solving ability is very important for getting good mathematics results at both school and university (Q10, 11).

In responses relating students' concept of university learning and the necessity of mathematics in their real life, all three groups agreed that they prefer mathematics to be taught at both school and university when it can be applied to real life situations (Q 8, 9). And all three groups believed that studying university mathematics is important for their future jobs (Q4).

Regarding parental influences, all three groups believed their parents expected them to do well in mathematics at both school and university (Q44, 45). All three groups believed that their parents encouraged them to study hard at both school and university mathematics (Q46, 47). In addition, all three groups believed that their good learning results came from their hard work at both school and university mathematics learning (Q16, 17), and all three groups agreed that they felt confident of doing well in mathematics at school (Q29). However, the responses to their confidence in university mathematics learning was different.

These results imply that the differences in students' family backgrounds and senior school environments did not significantly affect students' learning enthusiasm in some items. These items were regarding the link between learning enthusiasm and (i) self-esteem in learning capacity, (ii) future expectations, (iii) parental influences, and (iv) the importance of learning effort.

5.3 Attitudinal comparison regarding mathematical learning endeavour (the 'learned' component)

5.3.0 Introduction

In the literature review regarding students' attitudes and learning endeavours within mathematics study (see Chapter 2), students' attitudes towards learning endeavour are associated with a number of effective and affective factors, including learning effort, task difficulty, homework, support and encouragement, self and parental expectations, learning methods and strategies. This project was an attempt to clarify cross-cultural influences and related effective and affective factors regarding successful and unsuccessful learning methods and effort within school and university mathematics courses in different countries, with particular reference to Asian countries, via a students' perspective. Specifically, the project tried to identify following questions:

- Do those students have different attitudes toward learning endeavour ?
- Are students' successful or unsuccessful learning experiences different between students who have different senior secondary schools' experiences in different countries, with regard to Asian countries in particular?
- What are the nature of these attitudinal differences or similarities between the target groups for the above questions ?

Results from section 4.3.3 indicated that both students' attitudinal similarities and differences towards mathematics learning endeavour coexist in the three student groups (G1, G2, G3). Whilst in some questions, the average responses from the three groups were shown to be not significantly different (section 5.3.4), other questions showed significant differences. For example, significant attitudinal differences towards mathematics learning endeavour occurred in questions relating to learning endeavour and:

- poor learning results (Q14, 15)

- group discussion (Q26, 27)
- mathematical graphs and charts (Q30, 31)
- the organisation of mathematics courses (Q38, 39)
- the organisation of mathematics assessment (Q40, 41)
- ways mathematics was taught (Q42, 43)

Analysis for this component is presented in the following section using the four permutations of comparison for the three test groups (G1, G2 and G3):
Section 5.3.1 shows attitudinal differences between groups G1 and G2;
Section 5.3.2 shows attitudinal differences between groups G1 and G3;
Section 5.3.3 shows attitudinal differences between groups G2 and G3;
Section 5.3.4 shows attitudinal similarities in three test groups G1, G2 and G3.

5.3.1 Attitudinal differences regarding learning endeavour between group G1 and G2

The results in Chapter 4 (Table 4.3.3b) indicate that there are significant attitudinal differences between G1 and G2 in questions which are related to learning endeavour and:

- mathematical learning performance (Q1)
- the teaching methods in university (Q43)
- learning strategies (Q38, 39)
- assessment of university mathematics course (Q41)
- poor mathematical results (Q14, 15)

There are no significant attitudinal differences between G1 and G2 in questions which are related to learning endeavour and:

- the importance of learning school mathematics (Q6)
- mathematical graphs and charts (Q30, 31)
- group support (Q26, 27)
- teaching methods in schools (Q42)

- assessment of school mathematics (Q40)

The average responses by all students in groups G1 and G2 to the above questions are shown in Figure 5.3.1, which illustrates the attitudinal differences between groups G1 and G2.

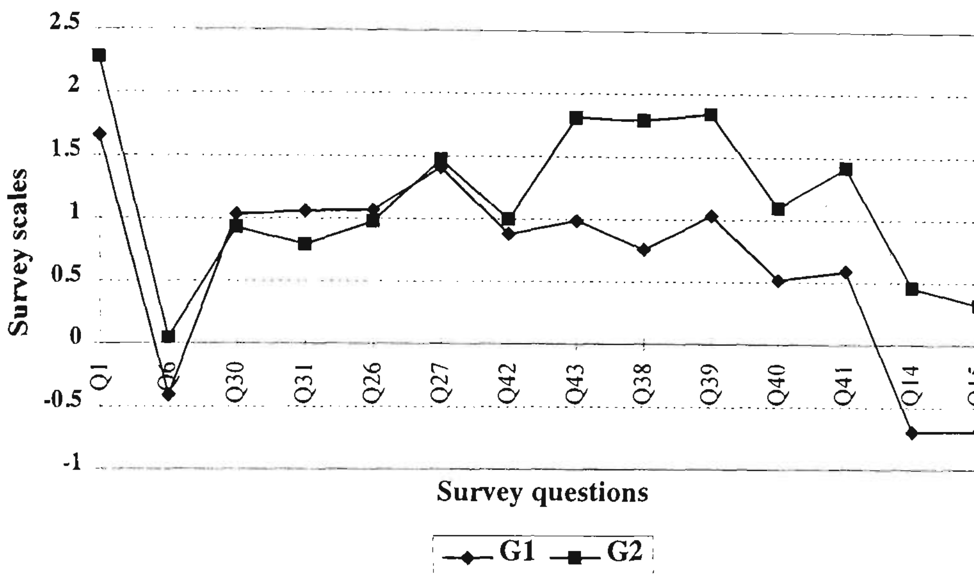


Figure 5.3.1 Attitudinal differences regarding learning endeavour between groups G1 and G2

Figure 5.3.1 indicates that both attitudinal similarities and differences occurred between groups G1 and G2.

Attitudinal similarities between G1 and G2 occurred in questions related to the link between learning endeavour and (i) using calculation, (ii) interpreting mathematical graphs and charts, and (iii) the help of discussion groups. Both G1 and G2 were uncertain whether or not their school learning outcomes could be improved through efforts on calculation (Q6). Both G1 and G2 believed that learning outcomes could be improved through using graphs and charts (Q30, 31) and through joining group discussion (Q26, 27). Both G1 and G2 indicated that previous teaching requirements of their school mathematics course were acceptable and their efforts were useful and effective (Q42). Consequently, both G1 and G2 believed that learning results were effected through their previous learning endeavour and results. These two groups believed that if students performed well in school mathematics, the students would perform well in university mathematics (Q1).

These results imply that the differences in students' family backgrounds did not affect students' attitudes toward their learning endeavour which were with regard to the items on learning skills in (i) calculation, (ii) interpreting mathematical graphs and charts, and (iii) joining discussion groups.

By contrast, attitudinal differences between groups G1 and G2 appeared in questions regarding the link between learning endeavour and (i) the way of teaching, (ii) mathematics course organisation and assessment, and (iii) poor learning results and learning ability. Both G1 and G2 indicated that previous teaching requirement of school mathematics course were acceptable, since both G1 and G2 indicated that they liked the way of mathematics was taught in year 12 (Q42). More positively, G2's response imply that they were more satisfied with the way of teaching and their study efforts in learning university mathematics than school mathematics (Q42, 43). Also, comparing G1, G2 more positively indicated that the organisation of university mathematics courses did guide their learning methods and endeavour. They believed that the organisation of the mathematics course in year 12 and in university were helpful for their learning (Q38, 39). Also, G2's responses indicated that they put more effort into preparing for school and university mathematical course assessment. G1, however, was uncertain whether the organisation of assessment in school and university mathematics made them work hard throughout the year (Q40, 41).

Specifically in regard to poor learning outcomes, both G1 and G2 were aware that learning endeavour is important for improved learning results, since both G1 and G2 did not completely attribute poor mathematical learning to lack of ability (Q14, 15). The responses of G1 indicated they were more confident in their learning ability than G2, since G1 was less likely to attribute their poor learning results to lack of ability (Q14, 15).

These results imply that the differences in learning strategies and learning methods occurred in the students who have different family backgrounds, since G1 and G2 studied year 12 in the same country but were born in different countries.

5.3.2 Attitudinal differences regarding learning endeavour between groups G1 and G3

The results in Chapter 4 (Table 4.3.3b) indicate that there are significant attitudinal differences between G1 and G3 in questions which are related to learning endeavour and:

- mathematical learning performance (Q1)
- the importance of learning school mathematics (Q6)
- mathematical graphs and charts (Q30, 31)
- group support (Q26, 27)
- teaching methods (Q42, 43)
- learning strategies (Q38, 39)
- assessment of mathematics course (Q40, 41)
- poor mathematical results at university (Q14, 15)

The average responses by all students in groups G1 and G3 to the above questions are shown in Figure 5.3.2 which illustrates the attitudinal differences between groups G1 and G3.

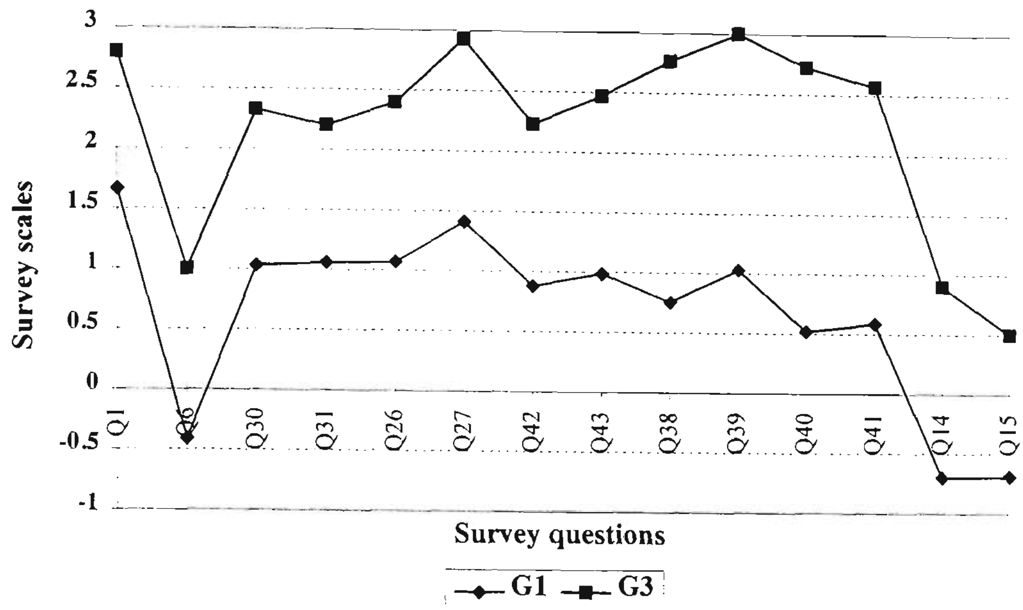


Figure 5.3.2 Attitudinal differences regarding learning endeavour between groups G1 and G3

Figure 5.3.2 indicates that attitudinal differences occurred between groups G1 and G3.

Attitudinal differences between groups G1 and G3 appeared in questions regarding the link between learning endeavour and the way of learning including (i) the affect by previous learning performance, (ii) the skill of calculation and interpreting graphs and charts, and (iii) joining a discussion group. These attitudinal differences were apparent in the different levels of agreement shown by each group. Both G1 and G3 believed that learning results were effected through their previous learning endeavour and outcomes. These two groups believed that if students performed well in school mathematics, the students will perform well in university mathematics (Q1). Apart from the effect of previous learning performance, both G1 and G3 believed that learning results could be improved through using graphs and charts (Q30, 31) and through joining group discussions. They considered it especially important to join a discussion group when studying university mathematics (Q26, 27). Also, G3 slightly believed that school learning results could be improved through making efforts on calculation (Q6). However, G1 was uncertain whether or not their school learning results could be improved by putting much effort on calculation (Q6).

Attitudinal differences also occurred in the questions related to the link between learning endeavour and (i) the way of teaching, (ii) mathematics course organisation and assessment, and (iii) poor learning results and learning ability. Whilst group G1 tended to affirm their agreement, group G3 more positively indicated that they were more satisfied with the way of teaching in both university mathematics learning and school mathematics learning (Q42, 43). Also, compared with G1, G3 more positively indicated that the organisation and assessment of university mathematics course did guide their learning methods and endeavour (Q38, 39, 40, 41). They believed that the organisation of the mathematics course in year 12 and university was helpful for their learning (Q38, 39). G1, however, were uncertain whether the organisation of assessment in school and university mathematics made them work hard throughout the year (Q40, 41).

Finally, both G1 and G3 were aware that learning endeavour is important to improve learning results, since both G1 and G3 did not completely attribute poor mathematical learning to lack of ability (Q14, 15). The responses of G1 indicated that G1 were more confident in their learning ability than G3, since G1 saw less contribution to poorly learned results due to lack of ability (Q14, 15).

5.3.3 Attitudinal differences regarding learning endeavour between groups G2 and G3

The results in Chapter 4 (Table 4.3.3b) indicate that there are significant attitudinal differences between G2 and G3 in questions which are related to learning endeavour and:

- mathematical graphs and charts (Q30, 31)
- group support (Q26, 27)
- the teaching methods in university (Q42)
- learning strategies (Q38, 39)

- assessment of mathematics course (Q40, 41)

There are no significant attitudinal differences between G2 and G3 in questions which are related to learning endeavour and:

- mathematical learning performance (Q1)
- the importance of learning school mathematics (Q6)
- the teaching methods in university (Q43)
- poor mathematical results (Q14, 15)

The average responses by all students in groups G2 and G3 to the above questions are shown in Figure 5.3.3, which illustrates the attitudinal differences between group G2 and G3.

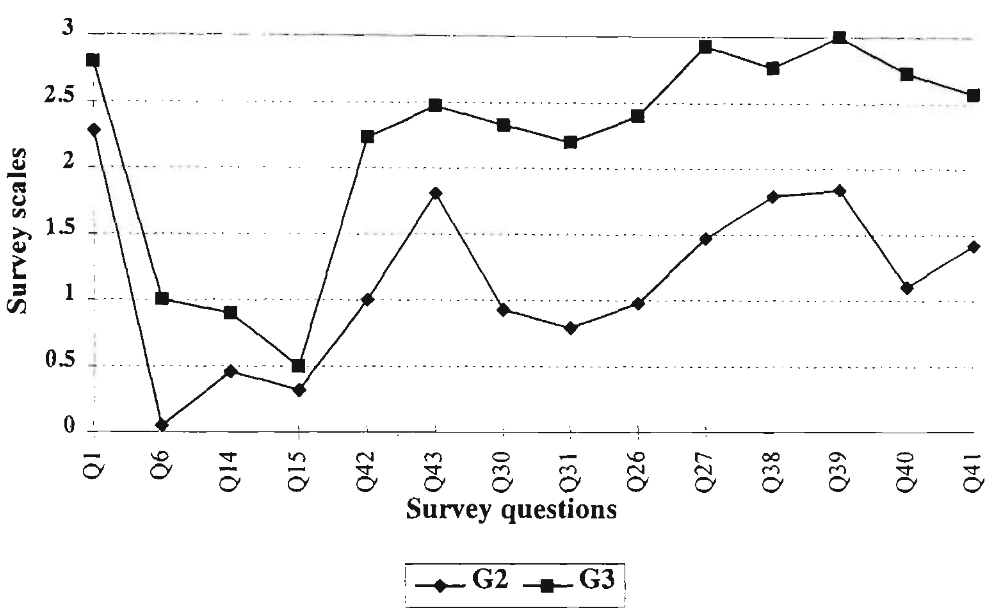


Figure 5.3.3 Attitudinal differences regarding learning endeavour between groups G2 and G3

Figure 5.3.3 indicates that both attitudinal similarities and differences occurred between groups G2 and G3.

Attitudinal similarities between G2 and G3 appeared in questions regarding the link between learning endeavour and (i) previous learning performance, (ii) poor learning outcomes and innate ability, and (iii) the way of teaching. Both groups G2 and G3 indicate that previous learning performance affects learning effort, since these two groups believed that if students performed well in school mathematics, the students will perform well in university mathematics (Q1). Both G2 and G3 were aware that learning endeavour is important to improved learning results, since both G2 and G3 did not completely attribute their poor mathematical learning to lack of ability (Q14, 15). Also, G3 slightly believed that effort on calculation could improve school learning results (Q6). However, G2 was uncertain whether or not their school learning results could be improved through effort on calculation (Q6).

These results imply that the differences in pedagogic environments in different countries did not affect students' attitudes towards the interaction between learning effort, learning outcome and effect of previous learning performance, and the interaction between learning effort, innate learning ability and poor learning results.

By contrast, attitudinal differences between groups G2 and G3 appeared in questions relating the link between learning endeavour and (i) the way of teaching in school, but not in university, including using and interpreting graphs and charts, (ii) joining discussion group, and (iii) course organisation and assessment.

Regarding the way of teaching, attitudinal differences appeared in the way of teaching in school, but no attitudinal differences appeared in the way of teaching in university (Q42, 43). Whilst G2 tended to agree that the teaching in school was effective and helpful, G3 more positively indicated that previous teaching requirements of school and university mathematics courses were acceptable and their efforts were useful and effective (Q42, 43). In addition, both G2 and G3 indicated that they were more satisfied with the teaching and their study efforts in university mathematics learning than school mathematics learning (Q42, 43).

Regarding the specific items on learning methods, G3 more positively than G2 believed that learning outcomes might be improved by developing the skill of interpreting graphs and charts (Q30, 31) and through joining group discussions. This was seen as especially important at university (Q26, 27). Both groups G2 and G3 believed that the organisation of the mathematics course in year 12 and university was helpful for their learning (Q38, 39). Regarding course assessment, both G2 and G3 indicated that they paid much effort to preparing for school and university mathematical course assessment. G3, however, strongly agree that the organisation of assessment in school and university mathematics made them work hard throughout the year (Q40, 41).

These results indicate that the differences in pedagogic learning environments did affect students' attitudes towards their learning effort and the ways of teaching and learning, which were related to the specific items of interpreting graphs and charts, joining groups, course organisation and assessment.

5.3.4 Attitudinal similarities regarding learning endeavour among the three groups (G1, G2, G3)

The results in Chapter 4 (Table 4.3.3a) indicate that attitudinal similarities towards learning endeavour occurred in the questions relating to learning endeavour and:

- good and poor learning results (Q12,13, 16, 17, 18, 19)
- concept of mathematical intelligence (Q2, 3)
- the importance of teachers and lecturers (Q32, 33)
- the preference of learning on one's own (Q24, 25)
- mathematical learning results associated with memory, and calculation (Q20, 21, 34, 35, 7)
- task difficulty between school and university learning (Q36)
- the necessity of mathematics learning being associated with life situations (Q8, 9)
- parental influences to students' learning effort (Q46, 47, 48, 49)

The average responses by all students in groups G1, G2 and G3 to the above questions are shown in Figure 5.3.4 which illustrates the attitudinal similarities among the three target groups (G1, G2, G3).

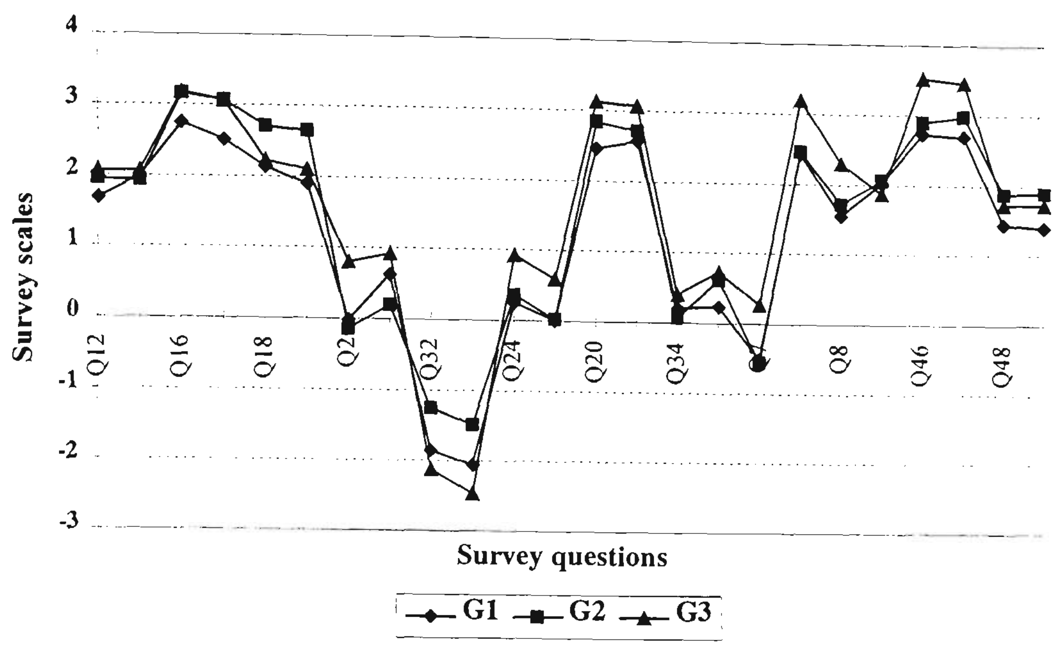


Figure 5.3.4 Attitudinal similarities regarding learning endeavour among G1, G2 and G3

Figure 5.3.4 indicates that there were no significant attitudinal differences towards mathematical learning endeavour on these questions.

First of all, attitudinal similarities appeared in the question regarding students' attitudes towards their successful and unsuccessful learning outcomes. All three groups attributed their good learning results to their learning ability and effort. The three groups believed that when they did well in mathematics at school and university it was because of their ability (Q13, 12). They also agreed that when they did well in mathematics at school and university it was because they worked hard (Q17, 16). Effort was also attributed to poor learning results. All three groups believed that when they did poorly in mathematics at school and university it was because of their lack of effort (Q19, 18). The three groups were uncertain whether or not people who are good at school or university mathematics are intelligent (Q2, 3).

Secondly, attitudinal similarities appeared in the questions regarding learning affective and effective factors. The learning derived from teachers or lecturers was emphasised more than learning on their own, since all three groups did not agree that it is possible to get good mathematical results at school or university without a good mathematics teachers or lecturers (Q32, 33). They were not sure whether or not they prefer to do school or university mathematics on their own (Q24, 25).

Regarding the concept of students' learning methods, all three groups certainly believed that a good memory is important for learning mathematics at school and university (Q 20, 21). However, they were uncertain whether or not school or university mathematics is mainly learned by memorising rules and formulae (Q34, 35). They were also uncertain whether or not the main reason they study mathematics at university was to do calculations (Q7). All three groups believed that university mathematics is harder than school mathematics (Q36). They preferred mathematics at school and university that can be applied to real life situations (Q8, 9).

Finally, in the questions regarding parental attitudinal influences to their learning effort, all three groups certainly agreed that their parents encouraged them to study hard at school and university (Q46, 47). Comparatively, all three groups slightly agreed that their parents insisted that they study hard at school and university (Q48, 49).

These results indicate that beliefs in the importance of memory occurred in the three groups who were born and studied year 12 in different countries: Australia, overseas and Asian countries. And the three groups attributed their good learning results to both ability and effort. This result is similar to Lewis (1989) who indicated that success attributions to effort and luck were most consistent, while attribution of success to ability and task difficulty appeared to be the most common. However, these results further indicate that students attribute their good results more to effort than ability. This further indication is different to the research by Ryckman & Mizokawa (1988) who indicate that, while academic success or failure was attributed more to effort than ability by both Asian and Whites groups, the Asians as a group tended to emphasise effort more than Whites. This pattern was reversed for ability. Also, Ryckman & Mizokawa (1988) indicated that students believed that a lack of effort is more a cause of failure in language and arts than in mathematics and science.

In the questions relating to parental attitudinal influences, all three groups certainly agreed that their parents encouraged them to study hard at school and university (Q46, 47). Comparatively, all three groups slightly agreed that their parents insisted they study hard at school and university (Q48, 49). It might be a cross cultural concept that parents are aware of the importance of effort and encourage students to pay more effort to their study. This result is also different to Ryckman & Mizokawa (1988). However, this result does not indicate the students attribute their successful learning results to effort as much as Izawa (1989) stated. Izawa (1989) indicated that any person of any colour or of any national origin with normal intelligence who works extraordinarily hard and strives for excellence will be educationally successful. These subjects also indicate the importance of beliefs about ability and learning strategies.

Chapter 6 Conclusion

The research questions that this study set out to examine were:

- are the different attitudes which Australian born and Asian born students exhibit towards Australian first-year university mathematics related to differences in the students' cultural backgrounds (*cultural effect*) ?
- are the different attitudes which Australian born and Asian born students exhibit towards Australian first-year university mathematics related to differences in the education system in which they completed their final year high school education (*educational effect*) ?

The outcomes of this research indicate that, for first year mathematics students at VUT, generally there are some significant differences in attitude toward first year university mathematics between students:

- with different family cultural backgrounds
- who studied final year secondary mathematics in different countries.

In an attempt to gain deeper insight into the generation of these differences, the nature of these attitudinal differences was examined in more specific detail by grouping questions which probed the genesis of student attitudes into three categories. These categories were:

- a cognitive category, which looked at students' attitudes toward mathematics as an outcome of their *learning ability* for mathematics. The results indicated that, for the various groups of students, students' attitudes differed as a result of responses made to issues dealing with demonstrated ability with mathematics, whereas, by contrast, no differences between groups were evidenced as a result of questions related to innate ability with mathematics.
- affective category, which looked at students' attitudes toward mathematics as an outcome of their *learning enthusiasm* for mathematics. Different student attitudes

emerged as a result of responses made to issues dealing with intrinsic drive and extrinsic drive for learning mathematics.

- a learned category, which looked at students' attitudes toward mathematics as an outcome of their *learning endeavour* for mathematics. For the various groups of students, attitudes differed as a result of responses made to issues dealing with unsuccessful learning outcome with mathematics, but no differences between groups was evidenced as a result of questions related to successful learning outcomes with mathematics.

In the three categories, these observations of differences held for both questions related to the effects on student attitude by family cultural effects as well as for the influence of the students' secondary school environment.

These results are summarised in Figure 6.1. The '== ' indicates that there are no attitudinal differences between the groups for that particular category, whilst '=\=' indicates that there is a statistically significant difference between the groups. An example of an item which has been investigated in this category has been attached under that summary triangle. In some categories, the differences between the groups is unclear, since some items in the category show differences whilst others do not. In this case, the symbol '=?=' has been used.

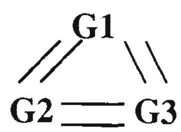
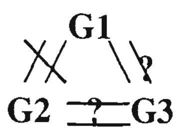
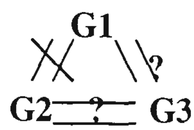
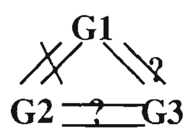
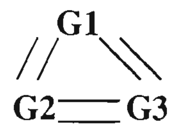
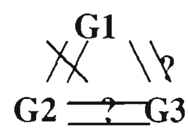
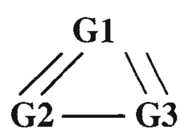
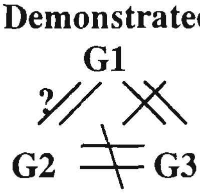
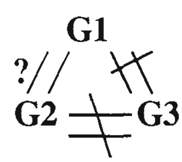
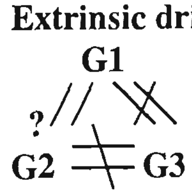
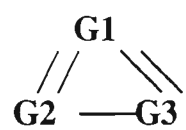
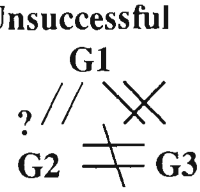
	Learning ability (cognitive)	Learning enthusiasm (affective)	Learning endeavour (learned)
6.1 Cultural effects on attitudes to mathematics	Innate ability  eg. memory Demonstrated  eg. understand graphs and charts 6.1.1	Intrinsic drive  eg. enjoyment Extrinsic drive  eg. parental affects, future job 6.1.2	Successful  eg. effort or ability Unsuccessful  eg. poor outcome and effort 6.1.3
6.2 Education environment effects on attitudes to mathematics	Innate ability  eg. memory Demonstrated  eg. calculation 6.2.1	Intrinsic drive  eg. enjoyment Extrinsic drive  eg. peer or parental affects 6.2.2	Successful  eg. good outcome and effort or ability Unsuccessful  eg. join discussion group 6.2.3

Figure 6.1 Summary of research findings

Figure 6.1 shows the relationship between the two main foci of the investigation:

- Cultural effects on attitudes to mathematics
- Education environment effects on attitudes to mathematics

Three categories which were introduced to give more depth to the student responses:

- Learning ability (cognitive). In this category, innate and demonstrated abilities have been presented as separate categories, but it is recognised that the items contained within these categories may overlap to some extent referring to innate and demonstrated abilities.
- Learning enthusiasm (affective). In this category, intrinsic and extrinsic drive have been presented as separate categories, but again it is recognised that the items contained within these categories may overlap to some extent.
- Learning endeavour (learned). In this category, successful and unsuccessful learning have been presented as separate categories, but it is recognised that the items contained within these categories may also overlap to some extent.

6.1 The effect of cultural background on attitudes to mathematics

The following three sections (6.1.1, 6.1.2, 6.1.3) use the categories indicated above to describe the relationship between family cultural differences and attitudinal differences which arose from the responses to specific items related to student learning.

6.1.1 Learning ability

For students who have different family cultural backgrounds, the results (Section 5.1) of students' average responses showed that no significant attitudinal differences between students appeared for the items relating to innate ability with mathematics learning, such as memory or general concept about intelligence. However, differences in student attitudes appeared in the responses to questions about their demonstrated ability with mathematical functions (eg. interpreting graphs and charts, learning strategies). These results suggest that the differences in students' family cultural backgrounds may be in some way related to students' attitudes towards mathematics as a result of their demonstrated ability.

6.1.2 Learning enthusiasm

For the students who have different family backgrounds, the results (Section 5.2) of students' average responses showed that attitudinal differences appeared in the items relating to both intrinsic drive (eg. mathematical enjoyment) and extrinsic drive (eg. peer influence). These results imply that the differences in students' family backgrounds could affect students' intrinsic learning drive, which mainly occurred in the items regarding the way of discovering mathematical learning enjoyment, and learning confidence. Also, the differences in students' family backgrounds could affect students' attitudes toward their extrinsic learning drive, which mainly occurred in items regarding parental influences and the expectations of future employment.

6.1.3 Learning endeavour

The results (Section 5.3) of students' average responses showed that there were no attitudinal differences appearing in the items relating to successful learning (eg. good outcomes and effort or good innate ability). However, attitudinal differences appeared in the items relating to their unsuccessful learning (eg. poor outcome and effort or previous learning experiences). These results imply that whilst students' family backgrounds did not affect students' attitudes towards successful learning, differences in students' family backgrounds could affect students' attitudes toward unsuccessful learning. These difference mainly occurred in items regarding the strategies students used for learning tasks.

6.2 The effect of education environment on attitudes to mathematics

The following three sections use the categories indicated above (Figure 6.1) to describe the relationship between differences on students' education environment and attitudinal differences which arose from the responses to specific items related to students' mathematics learning. The observations held for both questions related to the effects on student attitude by their first year university experiences as well as for the influences of the students' final year high school environment.

6.2.1 Learning ability

For those students who studied their final year high school mathematics in Australia or Asian countries, the results (Section 5.1) of students' average responses regarding mathematical learning ability showed that differences in educational environment did not alter students' perception that their innate ability (such as memory, general concept about intelligence) influenced their attitude to mathematics learning. However, differences in attitudes towards mathematics arose from differences in demonstrated ability (e.g. learning outcomes, learning strategies, and being able to find mathematical enjoyment). These results imply that the differences in educational environments arising from the manifestation of students' demonstrated ability with mathematics in different countries could affect students' attitudes toward mathematics.

6.2.2 Learning enthusiasm

For the students who studied their final year high school mathematics in Australia or Asian countries, the results (Section 5.2) of students' average responses regarding mathematical learning enthusiasm showed that attitudinal differences appeared in the items relating to both intrinsic drive (eg. mathematical enjoyment) and extrinsic drive (eg. peer influence). These results imply that the differences in educational environments could arise from students' intrinsic learning drive, which appeared in those items regarding the way of discovering mathematical learning enjoyment, and learning confidence. Also, differences in students' learning environments could be affected by students' attitudes toward their extrinsic learning drive which mainly occurred in items regarding peer influences and course assessment.

6.2.3 Learning endeavour

For students who studied their final year school mathematics in Australia and Asian countries, the results (Section 5.3) of students' average responses regarding mathematical learning endeavour showed that no significant attitudinal differences appeared in the items relating to successful learning (eg. good outcomes and effort or good innate ability). However, attitudinal differences appeared in these items related to unsuccessful learning experiences, which implies that negative experiences associated with the students' learning environment (such as difficulty in joining discussion groups and adjusting to different teaching methods, poor course organisation, unfair assessment and difficulty understanding graphs and charts) have a significant impact on students' attitudes to mathematics.

6.3 Implications and future research directions

Based on the results of 6.1.1, it is suggested that:

- in a class in which students have different family cultural backgrounds, the students need more opportunity for sharing their different ways of discovering mathematical enjoyment. These ways could include students sharing their learning methods for understanding and using graphs and charts, and discussing alternative learning strategies.
- Further study should focus on the differences between Australian born and Asian born students' tendency to attribute their poor learning outcomes to their ability.

Based on the results of 6.1.2, it is suggested that:

- future jobs and parental interests are an important part of encouraging students' learning. Mathematics teaching should be associated with students' expectations of future jobs and their parental support.
- further study should focus on the different concept/understanding of mathematical enjoyment between Australian born and Asian born students. Also, research should focus on the positive learning reinforcement and enhanced learning achievement from joining a discussion group between Australian born and Asian born students.

Based on the results of 6.1.3, it is suggested that:

- in a class with students who have different family backgrounds, teaching students the learning methods and creating opportunities for students to share their successful and unsuccessful learning experiences are an important part of a mathematics class.
- there are no attitudinal differences from students' responses relating the relationship between cultural difference and successful learning outcome. Learning effort and innate ability were emphasised by all three groups. However, attitudinal differences occurred in their beliefs about unsuccessful learning outcomes. In further studies it will be important to focus on students' different responses to their poor learning results. These unsuccessful learning experiences could provide useful information for developing successful learning methods.

Based on the results of 6.2.1, it is suggested that:

- the learning experiences and learning methods of students who learned their senior high school mathematics in Australian and Asian countries are an important way for students to enrich their learning capacity and develop their learning ability. It is important to create opportunities of employing and sharing their learning methods and learning strategies, which have been obtained from both high school and university learning.

- for the students from senior high schools in Australia and Asian countries, further study should focus on students' different attribution and responses to the relationship between their poor learning outcome and their ability.

Based on the results of 6.2.2, it is suggested that:

- peer influences and parental interest are important in encouraging student learning. The students who attended senior high school in Australian and Asian countries have different concepts and understandings about mathematical enjoyment. It is an important part of the mathematics class to create a positive learning circumstance through students' communication to develop their concepts and understandings about mathematical enjoyment.

Based on the results of 6.2.3, it is suggested that:

- the differences between the students from senior high schools in Australia and Asian countries occurred in their unsuccessful learning outcomes. For these students, how to recognise and remedy their unsuccessful learning experiences appear important for their further study and learning attitude.
- in further studies, it will be important to focus on the students' different responses to their poor learning results including the different methods of learning independently, individually or joining students' discussion groups. These unsuccessful learning experiences could provide useful information for developing successful learning methods and maintaining positive learning attitudes.

In summary, the study confirmed that attitudinal differences to mathematics occur between students and is appears that these can be associated with cultural background. Further research in this area could provide valuable data to improve students' attitudes to mathematics.

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Appendix I. Pilot questionnaire

Please indicate the following:

Sex: Female☐ Male☐ Age:__________

Country of Birth ________________

If not born in Australia, how long have you been in Australia?______years

Are you: An Australian citizen? ☐

Australian resident? ☐

On a student visa? ☐

In which country did you study year 12 Mathematics? ______________

Name of the School____

The name of your present university course ________________________

****

PLEASE PLACE A TICK IN THE BOX THAT MOST ACCURATELY DESCRIBES YOUR FEELING ABOUT MATHEMATICS

****

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
I believe that students who form well in mathematics at ool will perform well in hematics at university.	☐	☐	☐	☐	☐	☐
I believe people who are d at school mathematics intelligent.	☐	☐	☐	☐	☐	☐
I believe people who are good niversity mathematics are lligent.	☐	☐	☐	☐	☐	☐
I believe that studying ersity mathematics is ortant for my future job.	☐	☐	☐	☐	☐	☐
I believe that studying school hematics is important for ing a job.	☐	☐	☐	☐	☐	☐

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
6› The main reason I studied mathematics at school was to learn how to do calculations.	☐	☐	☐	☐	☐	☐
7› The main reason I study mathematics at university is to do calculations.	☐	☐	☐	☐	☐	☐
8› I preferred mathematics at school when it could be applied to real life situations.	☐	☐	☐	☐	☐	☐
9› I prefer mathematics at university when it can be applied to real life situations.	☐	☐	☐	☐	☐	☐
10› I believe problem-solving ability is very important for getting good mathematics results at school.	☐	☐	☐	☐	☐	☐
11› I believe problem-solving ability very important for getting good mathematics results at university.	☐	☐	☐	☐	☐	☐
12› When I do well in mathematics university it is because of my ability.	☐	☐	☐	☐	☐	☐
13› When I did well in mathematics school it was because of my ability.	☐	☐	☐	☐	☐	☐
14› When I did poorly in mathematics school it was because of my lack of ability.	☐	☐	☐	☐	☐	☐
15› When I do poorly in mathematics university it is because of my lack ability.	☐	☐	☐	☐	☐	☐

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
6) When I do well in mathematics university it is because I work rd.	☐	☐	☐	☐	☐	☐
7) When I did well in mathematics school it was because I worked rd.	☐	☐	☐	☐	☐	☐
8) When I do poorly in mathematics university it is because of my k of effort.	☐	☐	☐	☐	☐	☐
9) When I did poorly in mathematics school it was because of my lack effort.	☐	☐	☐	☐	☐	☐
0) I believe good memory is portant for learning mathematics school.	☐	☐	☐	☐	☐	☐
1) I believe good memory is portant for learning mathematics university.	☐	☐	☐	☐	☐	☐
2) I believe that the mathematics id at school brought enjoyment to y life.	☐	☐	☐	☐	☐	☐
3) I believe that university thematics brings enjoyment to y life.	☐	☐	☐	☐	☐	☐
4) I preferred to do school thematics on my own.	☐	☐	☐	☐	☐	☐
5) I prefer to do university thematics on my own.	☐	☐	☐	☐	☐	☐

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
) I preferred to do school thematics in small discussion ups.	☐	☐	☐	☐	☐	☐
) I prefer to do university thematics in small discussion ups.	☐	☐	☐	☐	☐	☐
) I feel confident of doing well mathematics at university.	☐	☐	☐	☐	☐	☐
) I felt confident of doing well athematics at school.	☐	☐	☐	☐	☐	☐
) I believe graphs and charts people understand university thematical ideas.	☐	☐	☐	☐	☐	☐
) I believe graphs and charts ed people understand school thematical ideas.	☐	☐	☐	☐	☐	☐
) I believe it is possible to get d mathematical results at school hout good mathematics teachers.	☐	☐	☐	☐	☐	☐
) I believe it is possible to get good hematical results at university hout good mathematics lecturers.	☐	☐	☐	☐	☐	☐
) I believe university mathematics ainly learnt by memorising rules formula.	☐	☐	☐	☐	☐	☐
) I believe school mathematics is nly learnt by memorising s and formula.	☐	☐	☐	☐	☐	☐

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
‹36› I believe university mathematics is harder than year 12 mathematics.	☐	☐	☐	☐	☐	☐
‹37› I believe university mathematics is more enjoyable than year 12 mathematics.	☐	☐	☐	☐	☐	☐
‹38› I believe the organisation of assessment in year 12 made me work hard throughout the year.	☐	☐	☐	☐	☐	☐
‹39› I believe the organisation of assessment in university makes me work hard throughout the year.	☐	☐	☐	☐	☐	☐
‹40› I believe the organisation of the mathematics course and assessment in year 12 was helpful for my learning.	☐	☐	☐	☐	☐	☐
‹41› I believe the organisation of the mathematics course and assessment in university is helpful for my learning.	☐	☐	☐	☐	☐	☐
‹42› I liked the way mathematics was taught in year 12.	☐	☐	☐	☐	☐	☐
‹43› I like the way mathematics is taught in university.	☐	☐	☐	☐	☐	☐

Appendix II. Main questionnaire

Personal details

Name:________________________ Student number__________________

Sex (circle the appropriate letter) M F Age:___________________

Country of Birth ____

If not born in Australia, how long have you been in Australia?__________________years

Country of your father's birth____,

The highest level of qualification attained by your father___________________________

Country of your mother's birth____

The highest level of qualification attained by your mother__________________________

In which country did you study year 12 Mathematics? ____________________________

Name of the School____

The name of your present university course _____________________________________

****

PLEASE PLACE A TICK IN THE CIRCLE THAT MOST ACCURATELY DESCRIBES YOUR FEELING ABOUT MATHEMATICS

****

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
1. I believe that students who perform well in mathematics at school will perform well in mathematics at university.	O	O	O	O	O	O
2. I believe people who are good at school mathematics are intelligent.	O	O	O	O	O	O
3. I believe people who are good at university mathematics are intelligent.	O	O	O	O	O	O
4. I believe that studying university mathematics is important for my future job.	O	O	O	O	O	O

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
5. I believe that studying school mathematics is important for getting a job.	O	O	O	O	O	O
6. The main reason I studied mathematics at school was to learn how to do calculations.	O	O	O	O	O	O
7. The main reason I study mathematics at university is to do calculations.	O	O	O	O	O	O
8. I preferred mathematics at school when it could be applied to real life situations.	O	O	O	O	O	O
9. I prefer mathematics at university when it can be applied to real life situations.	O	O	O	O	O	O
10. I believe problem-solving ability is very important for getting good mathematics results at school.	O	O	O	O	O	O
11. I believe problem-solving ability is very important for getting good mathematics results at university.	O	O	O	O	O	O
12. When I do well in mathematics at university it is because of my ability.	O	O	O	O	O	O
13. When I did well in mathematics at school it was because of my ability.	O	O	O	O	O	O
14. When I did poorly in mathematics at school it was because of my lack of ability.	O	O	O	O	O	O
15. When I do poorly in mathematics at university it is because of my lack of ability.	O	O	O	O	O	O

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
16. When I do well in mathematics at university it is because I work hard.	O	O	O	O	O	O
17. When I did well in mathematics at school it was because I worked hard.	O	O	O	O	O	O
18. When I do poorly in mathematics at university it is because of my lack of effort.	O	O	O	O	O	O
19. When I did poorly in mathematics at school it was because of my lack of effort.	O	O	O	O	O	O
20. I believe good memory is important for learning mathematics at school.	O	O	O	O	O	O
21. I believe good memory is important for learning mathematics at university.	O	O	O	O	O	O
22. I believe that the mathematics I did at school brought enjoyment to my life.	O	O	O	O	O	O
23. I believe that university mathematics brings enjoyment to my life.	O	O	O	O	O	O
24. I preferred to do school mathematics on my own.	O	O	O	O	O	O
25. I prefer to do university mathematics on my own.	O	O	O	O	O	O
26. I preferred to do school mathematics in small discussion groups.	O	O	O	O	O	O
27. I prefer to do university mathematics in small discussion groups.	O	O	O	O	O	O

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
28. I feel confident of doing well in mathematics at university.	O	O	O	O	O	O
29. I felt confident of doing well in mathematics at school.	O	O	O	O	O	O
30. I believe graphs and charts help people understand university mathematical ideas.	O	O	O	O	O	O
31. I believe graphs and charts helped people understand school mathematical ideas.	O	O	O	O	O	O
32. I believe it is possible to get good mathematical results at school without good mathematics teachers.	O	O	O	O	O	O
33. I believe it is possible to get good mathematical results at university without good mathematics lecturers.	O	O	O	O	O	O
34. I believe university mathematics is mainly learnt by memorising rules and formula.	O	O	O	O	O	O
35. I believe school mathematics is mainly learnt by memorising rules and formula.	O	O	O	O	O	O
36. I believe university mathematics is harder than year 12 mathematics.	O	O	O	O	O	O
37. I believe university mathematics is more enjoyable than year 12 mathematics.	O	O	O	O	O	O
38. I believe the organisation of the mathematics course in year 12 was helpful for my learning.	O	O	O	O	O	O
39. I believe the organisation of the mathematics course in university is helpful for my learning.	O	O	O	O	O	O

	disagree strongly	disagree	disagree slightly	agree slightly	agree	agree strongly
I believe the organisation of ssment in year 12 made me k hard throughout the year.	O	O	O	O	O	O
I believe the organisation of ssment in university makes me k hard throughout the year.	O	O	O	O	O	O
I liked the way mathematics taught in year 12.	O	O	O	O	O	O
I like the way mathematics ught in university.	O	O	O	O	O	O
I believe that my parents ected me to do well in hematics at school.	O	O	O	O	O	O
I believe that my parents ect me to do well in hematics at university.	O	O	O	O	O	O
When I was at school, my nts encouraged me to y hard .	O	O	O	O	O	O
My parents encourage me to y hard at university.	O	O	O	O	O	O
When I was at school, my nts insisted that I study hard.	O	O	O	O	O	O
My parents insist that I study at university.	O	O	O	O	O	O
I like my parents to show iterest in my study.	O	O	O	O	O	O