

**A COMPARATIVE STUDY OF GENDER-RELATED ATTITUDES
TOWARDS MATHEMATICS BETWEEN STUDENTS WHO TAKE
ADVANCED MATHEMATICS IN CYPRUS AND ENGLAND**

Thesis submitted for the degree of
Doctor of Philosophy
at the University of Leicester

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2012

A comparative study of gender-related attitudes towards mathematics between
students who take advanced mathematics in Cyprus and England

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ABSTRACT

This mixed-method study explores the attitudes towards mathematics of sixth form high achieving students opting for advanced mathematics in Cyprus and England. The study aimed to examine differences or similarities between male and female students in Cyprus and England in terms of their attitudes towards mathematics and compare them within and across the two countries. In addition, the study aimed to develop an insight into the factors that may influence the attitudes towards mathematics of male and female students in the two countries involved. Data were collected through a Likert-scale questionnaire and a semi-structured interview. Factor Analysis was employed for the questionnaire data which was followed by Multivariate Analysis of Variance (MANOVA) and post-hoc tests. The interview data were analysed using thematic analysis. The study revealed that the overwhelming majority of students in Cyprus and England had positive attitudes towards mathematics (i.e. a utilitarian view of mathematics, interest in mathematics, and desire to pursue studies in mathematics-related fields). Findings from the study also indicate that perceived parental/teacher influence in mathematical learning had a positive impact on students' attitudes towards mathematics. However, a small number of students in both countries expressed negative feelings towards their mathematics teachers. The students in Cyprus often felt that the mathematics teachers at school did not play a significant role in their mathematical learning, because of the immense influence of private tutors in Cyprus. On the other hand, those students in England who expressed negative feelings towards their mathematics teachers attributed these feelings to their teachers' teaching styles and personality. In addition, findings suggest that female students in Cyprus had a less gender stereotypical view of mathematical ability compared to female students in England and male students in Cyprus. Conversely, for both male and female students in England mathematics was an area of strong male significance in a symbolic sense (i.e. images of male mathematicians dominating higher-level mathematics, or thoughts of boys being naturally good at mathematics and girls being good at languages, etc.).

ACKNOWLEDGEMENTS

Throughout the entire process of my PhD programme, I have relied on the support of many tremendous people. First of all, I wish to express my utmost gratefulness to my supervisor, Professor Janet Ainley. For without the wisdom and guidance of this extraordinary scholar, this work would have not been possible. Thank you for the generosity of your time, your helpful and constructive feedback, and for creating an environment where I could safely and certainly grow in scholarship.

I would like also to express my gratitude to my second supervisor an outstanding academic, Dr. Tony Lawson, for taking extra time to provide me with additional attention and support.

The head teacher and mathematics teachers of the participating lyceum in Cyprus and the college in England respectively should be also thanked for allowing me access in the lyceum and college. I am also thankful to all the students who participated in this study.

Last but not least, I would like to express my genuine gratitude to my parents, Christos and Constantia, for their unconditional love, support and for believing in me.

Natasha Christou

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CHAPTER 1

Introduction

1.1 Setting the Scene

The role of students' affective responses in mathematics is extremely important in their working and thinking in a mathematical task, and cannot be ignored in investigating students' cognition. Many researchers (e.g. Estrada, 2002; Furinghetti & Pehkonen, 2000; Kloosterman & Coogan, 1994; Kyriakou & Goulding, 2006; Leder & Forgasz, 2004; Leder, Pehkonen & Törner, 2002; Op't Eynde et al. 2006; Schoenfeld, 1992; Thompson, 1992; Tocci & Engelhard, 1991) argue that the learning outcomes of students are strongly related to their beliefs and attitudes towards mathematics. Attitudes towards mathematics in particular have been considered important in influencing participation and success in mathematics (e.g. Chipman, 2005; Pantziara & Philippou, 2009; Pellegrini & Blatchford, 2000). Brandell and Staberg (2008) also indicate that researchers have studied gender differences in attitudes towards mathematics extensively since the 1970s in order to understand the low participation of female students in higher education in mathematics.

1.2 Purpose and research questions of the study

The present study is concerned with a comparison of gender-related attitudes towards mathematics between sixth form high-achieving students who opt to take advanced mathematics in Cyprus (Greek-Cypriot students from the South part of

Cyprus) and England, and the factors that underlie their attitudes towards mathematics. The purpose of this study was to explore the attitudes towards mathematics of students in Cyprus and England, identify differences and/or similarities in their attitudes, and develop a deeper understanding of the factors that may shape and influence students' attitudes in each country. The study involved both statistical comparisons and interviews of gender-related attitudes towards mathematics between students in Cyprus and England. The rationale for administering questionnaires to students was to allow me to involve as many students as possible from the participating lyceum and college in order to identify differences and/or similarities in their attitudes. Conversely, interviews were conducted with a smaller number of students from both countries to obtain an insight into the factors underlying their attitudes. The general idea was to explore the attitudes towards mathematics of both students in Cyprus and England, find out some reasons why these attitudes were held, and make comparisons. Within the socio-cultural context of each country, it was expected that some attitudinal differences would exist between students in Cyprus and England.

When conducting this study, I was particularly interested in investigating attitudinal differences and/or similarities between female students in Cyprus and England, mainly because female students in Cyprus are inclined to choose to study mathematics at university level (Department of Statistics and Research, 2009) more often than female students in England who choose to study caring or art/humanities/social sciences subjects instead (Francis, 2002; Smithers &

Robinson, 2006). After reading Walkerdine's book "Counting Girls Out", I was fascinated with her views and findings regarding the "gender problem" in mathematics. Walkerdine (1998) talks about lack of equal opportunities in school mathematics and teachers' lower expectations for female students, with some females' successes at mathematics being discounted. When I was still at secondary school (1996-1997) in Cyprus opting for advanced mathematics I never noticed significant differences in attitudes towards mathematics between my female and male peers. There was also a balance between the numbers of male and female students opting for advanced mathematics in my mathematics classroom, and the mathematics teacher treated students equally. For that reason, I was very intrigued to explore gender-related attitudes towards mathematics of students in Cyprus, and compare them to those of students in England. By exploring the attitudes towards mathematics of students in these two countries, I will be able to identify attitudinal differences between them, which may have an impact upon other issues such as pursuit of mathematics to higher levels, and develop an understanding of the possible factors that shape and influence students' attitudes towards mathematics. Within this framework, the research questions that guided this study were:

1. Are there differences and/or similarities between students in Cyprus and England in terms of attitudes towards mathematics?
2. a) Are there differences between male and female students in Cyprus in terms of attitudes towards mathematics?

- b) Are there differences between male and female students in England in terms of attitudes towards mathematics?
 - c) If there are, how do these differences compare across the two countries?
3. How do social factors influence the attitudes of male and female students in Cyprus and England towards mathematics?

Albeit research in this area is an extremely complex process, due to the many factors and their inter-relatedness which impact on attitude, and the inherent problems encountered when measuring such variable as attitude, I am particularly interested in exploring how social factors (such as parents and teachers) influence students' attitudes towards mathematics and how this influence is different between the students in Cyprus and England. In my opinion attitude is a fundamental determinant of success or achievement in mathematics, whether it is in terms of attainment or continuous participation, and is a key factor in understanding students' behaviour in mathematics. Therefore, this evidence would have important implications.

My starting points in conducting this investigation were findings of a study by Mendick (2005a), and findings of a study by Papanastasiou and Zembylas (2006). Mendick's (2005a) study involved interviews and observation of 42 mathematics students aged between 16- and 19-years-old and one mature student, all of whom were in advanced mathematics courses and quite

successful in examinations. Out of the 43 participants interviewed about their experiences of learning mathematics, only four of them self-identified as “good at maths”. All four were male students and three of them belonged to the same mathematics teaching group (this group had chosen to study two qualifications in the subject). Mendick argues that within this group this identification was undoubtedly gendered for two reasons: all three students were male; and the two female further mathematics students put a lot of effort in their talks to deny the possibility of their being thought ‘mathematically able’ (p. 204).

On the other hand, Papanastasiou and Zembylas (2006) examined how different were the students in Cyprus who take advanced mathematics to those who do not. Their reason for carrying out this examination was controversial interpretations of the findings from the Third International Mathematics and Science Study (TIMSS 1995) which were related to the students from Cyprus. Specifically, results from TIMSS 1995 indicate that although Cypriot students did not perform well in mathematics in elementary, middle school, and in the non-advanced sectors of high school, the students in the advanced mathematics courses performed extremely well. Papanastasiou and Zembylas involved in their study 1224 Cypriot students who participated in TIMSS for high school seniors; 43% of those students were in non-advanced mathematics and science classes, while the other 57% were enrolled in advanced mathematics or science classes. From the whole sample of Cypriot students, 44.6% were female and 55.5% were male students. In addition, 53.7% of the students in the non-advanced group

were female, whereas only 38.2% of the students in advanced group were female. In order to analyse the data of their study, Papanastasiou and Zembylas tried to predict whether the students in the sample were in advanced or non-advanced mathematics classes based on various background and instructional characteristics. To do so, they used a series of regression logistics.

The first analysis of their data which examined whether the non-advanced and advanced mathematics students differed in terms of their attitudes towards mathematics, revealed a significant difference between them. According to Papanastasiou and Zembylas, the students who thought that mathematics was easy, not boring, important to our lives, and who would like to have a mathematics related career were more likely to be in the advanced mathematics classes. The second analysis, which examined whether there were differences in the characteristics of the class activities performed in students' mathematics classes, showed that the students who were in the advanced classes were involved in activities that included more higher-order thinking skills compared to those of the non-advanced students. In addition, Papanastasiou and Zembylas examined the daily activities of the students. The analysis revealed that the non-advanced mathematics students spent significantly more time on a normal school day with friends, doing jobs at home, working at a paid job, and studying or doing homework in school subjects other than mathematics and science. On the other hand, the advanced mathematics students spent significantly more time per day in doing mathematics homework. Finally, this study examined whether there

were differences in the educational levels of the parents of the students. The analysis showed that the parents of the advanced mathematics students were more highly educated compared to the parents of the non-advanced mathematics students. Specifically, 39.3% of the mothers and 30.5% of the fathers of the advanced students were college or university graduates. However, only 22.5% of the mothers and 55.2% of the fathers of the non-advanced students graduated from college or university.

Overall, Papanastasiou and Zembylas' (2006) study showed that there were significant differences between advanced and non-advanced mathematics students in Cyprus in terms of background and instructional characteristics. However, it is not clear whether these differences were a consequence of tracking, or whether these were differences, which led students choose a specific high school track. Papanastasiou and Zembylas conclude that the results of their study indicate that it is possible for students to be educated in an educational environment that might not be the best in producing high-achieving students in mathematics and science in the elementary and middle school (according to TIMSS), but still manage to do extremely well at the end of their schooling. Therefore, under certain circumstances, students can overcome such limitations and do extremely well in their fields of interest.

1.3 Significance of the Study

This study will make attitudinal-gender comparisons between high achieving students in Cyprus and England. This comparison has not been made extensively in research. Therefore, findings from this study will provide systematic and empirical information on students' attitudes towards mathematics between the two countries. The importance of the field of comparative education is indicated in Keeves' (1995) words:

“The provision of an educational system of the highest possible quality is of such importance to each and every country, that the field of comparative education has had a very important function in expansion in education” (p. 169).

The results of this study will stress the importance of positive attitudes towards mathematics. Students' attitudes towards mathematics can be a very useful tool not only for understanding students' mathematical behaviour, but also for predicting it. Students are likely to exert effort according to the effects they look forward to, which is controlled by their personal beliefs about their abilities, their perceptions about the utility of mathematics, their enjoyment of mathematics, and their motivation to succeed in this subject. By studying students' attitudes towards mathematics we will be able not only to understand why some students succeed and some others fail in mathematics, but also to understand why some students choose to take mathematics further during their education and some others don't.

In many countries, female students choose not to take mathematics at the upper secondary and tertiary levels of education. This low participation of female students in mathematics at higher levels can be problematic since mathematics is an essential component of studies in science and technology, and becomes more important in other areas such as economy. Therefore, a stable foundation in mathematics from secondary school makes possible tertiary studies in science, technology, and other mathematics related areas. Attitudes could be a possible reason for female students not taking mathematics further and many researchers in order to have a better understanding of a strongly gendered participation pattern in higher education in mathematics, studied attitudes towards mathematics extensively for four decades (e.g. Chipman, 2005; Leder, 1982). Negative attitudes towards mathematics among groups of students may be related to a low tendency to choose optional courses in mathematics (e.g. Brown et al. 2008; Nardi & Steward, 2003; Williams & Ivey, 2001). These negative attitudes may account for the low participation of women at higher-level studies in mathematics. Therefore, knowledge of women's reasons for choosing or not choosing mathematics is essential if we are interested in recruiting more women to mathematics, science, technology and other mathematics related fields.

Findings from this study may also inform us on how parents and teachers (as perceived by the students) influence students' attitudes towards mathematics and how this influence is different between the students from the two countries.

This information can be useful in promoting positive influences while attempting to avoid the negative influences of these sources. Moreover, it can offer a better understanding on the roles of parents and teachers in the formation of students' attitudes towards mathematics. The culture within Cyprus and England might also have an impact on students' attitudes towards mathematics. The findings can possibly offer an insight on whether the difference in culture within each country has led to differences in attitudes towards mathematics between the students in Cyprus and England.

1.4 Overview of the report

In Chapter 2 of my report, I discuss the different definitions offered concerning attitudes by others, and then present my own definition of attitudes towards mathematics, which I consider appropriate for this study. A discussion follows on gender and mathematics, and particularly on gender differences in mathematics participation, performance, and achievement. In order to explain differences in mathematics participation, performance and achievement I focus my attention on two explanations: a) that of internal-related factors (in this case attitudes); and b) and that of external environment-related factors. Chapter 3 involves a discussion on gender and educational choice in Cyprus and England. In Chapter 4, the educational system in Cyprus and England is discussed in detail. Chapter 5 entails a discussion on the research paradigms and a justification for the paradigm I have chosen for my study. Moreover, I discuss the methods used for this study. Finally, I explain how validity, reliability, and ethics were addressed in

this research project. In Chapter 6, findings from the questionnaire data analysis of the study are presented. Chapter 7 follows with a presentation of findings from the interview data analysis of the study that offers a deeper insight to the quantitative findings. Finally, in Chapter 8, the study is briefly summarized and the findings from both the questionnaire and interview data are synthesised and discussed in relation to the research questions of the study.

CHAPTER 2

Literature Review

2.1 Outline of Chapter 2

In this chapter, I consider different definitions given by others regarding attitudes and beliefs towards mathematics and then present the definition of attitudes towards mathematics adopted for this study. I then acknowledge gender differences in mathematics participation post-16 and mathematics performance and achievement in Cyprus and England. A discussion follows on the factors proposed by researchers in order to explain gender differences in mathematics with a particular focus on the factors that guided this study. Since I will be talking about the issue of gender 'inequality' I would like at this point to make a distinction between the different meanings of the words 'equity' and 'equality' as I have found contradictory definitions in other literature. In terms of gender relationships, the suggestion of the term 'equality of opportunity' is one of fairness or impartiality where an equal chance is being presented to both genders. However, the term 'equity' implies a suggestion of creating an equal state accomplished only when an equitable outcome occurs, following equality of opportunity.

2.2 Attitudes towards mathematics-Some theoretical considerations

Finding a clear theoretical framework for attitudes is a challenge in itself. Hannula (2004) points out that “there is a considerable diversity in the theoretical frameworks used in the conceptualisation of affect in mathematics education” (p. 107). Goldin (2000) sustains Hannula’s viewpoint by acknowledging that “we do not have a precise, shared language for describing the affective domain, within a theoretical framework that permits its systematic study” (p. 109). Therefore, I would like first to consider different definitions given by others regarding attitudes and beliefs about mathematics and then drawing upon these notions, present my definition of attitudes towards mathematics, which I regard as appropriate for this research project.

McLeod (1992) uses a simple definition for attitudes and describes them as persons’ reactions to negative or positive emotions. He accepts that “attitudes may result from the automatizing of a repeated emotional reaction to mathematics” or from “the assignment of an already existing attitude to a new but related task” (p. 576). He also points out that beliefs are more cognitive in nature than attitudes. Daskalogianni and Simpson (2000) use a bi-dimensional definition for attitudes towards mathematics. In this definition, behaviours do not appear explicitly. For them attitude towards mathematics is seen as the pattern of beliefs and emotions associated with mathematics. On the other hand, Hart (1989) defines attitudes towards mathematics using a multidimensional definition, which contains three components: an emotional respond to mathematics, either positive or negative; a conception about mathematics; and a behavioural tendency with

regard to mathematics. Ma and Kishor (1997) also suggest a wider definition and they regard attitude towards mathematics as:

“An aggregated measure of a liking or disliking of Mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at Mathematics, and a belief that Mathematics is useful or useless.” (p. 27)

According to Raymond (1997), however, beliefs about mathematics are:

“Personal judgements about mathematics formulated from experiences in school.” (p. 552)

These judgements consist of what McLeod (1992) calls “the objects of the beliefs”: beliefs about the nature of mathematics, the learning, and teaching of mathematics (p. 576). Raymond (1997) emphasises the importance of past experiences in school mathematics in shaping teachers’ and students’ personal beliefs. Ernest (1998a) also maintains that from the social constructivist view students’ beliefs about doing mathematics are the result of social processes of construction and negotiation of mathematical concepts and patterns, and of personal interactions in mathematics classrooms. Schoenfeld (1992) sustains that these beliefs can have an influence on how students conceptualise and do mathematics.

Drawing on these theoretical aspects, I regard beliefs as personal judgements about mathematics and doing mathematics, created from past and present experiences that form the ways by which students engage in any sort of mathematical activity (for example a student might hold a belief that mathematics means 'applying unreasonable rules' or that 'male students are better in mathematics than female students'). On the other hand, I regard attitudes as positive or negative responses to learning mathematics such as motivation, enthusiasm, interest, etc. (e.g. a student with positive attitude towards mathematics is someone who enjoys the learning of mathematics, and someone with negative attitude towards mathematics is someone who regards mathematics as dull and boring). Beliefs are a part of person's knowledge, are more stable than attitudes, and are influenced by social norms.

The attitude construct is often seen by many as a construct useful to the researcher's self-posed problems (e.g. Dascalogianni & Simpson, 2000; Ruffell, Mason, & Allen, 1998; Zan & Di Martino, 2007). In this study in order to understand students' attitudes towards mathematics, my intention was not only to determine the degree to which students like a mathematical topic, but also to identify their beliefs about mathematics and at the same time to try and find out possible factors that shape and influence their attitudes (e.g. social factors). My assumption is that students' perceptions of mathematics and the way they experience mathematics form their attitudes.

Having considered all the above definitions given regarding attitudes, the one adopted for this study is that attitudes towards mathematics involve two components: a mixture of emotional responses (either positive or negative) to learning mathematics such as liking/disliking of mathematics, anxiety towards mathematics, etc.; and beliefs which reflect a person's values and views and are based in ones' past and present experiences that shape their behaviour (these beliefs may include beliefs about the appropriateness of mathematics for males and females, the usefulness of mathematics, etc.).

2.3 Gender and Mathematics

Researchers have been focusing on the Gender and Mathematics issue internationally for over thirty years. A great amount of attention is made about the links between gender and the learning and teaching of mathematics particularly in the USA (e.g. Fennema, 2000; Hyde et al. 2008), but also to a smaller degree in Australia (e.g. Forgasz, 1995; Forgasz & Leder, 1996), Canada (e.g. Lloyd, Walsh, & Yailagh, 2005), and the UK (e.g. Ireson et al., 2001; Rogers, 2003; Walkerdine, 1998). There are also contributions on the issue outside the English-speaking world, for example Cyprus (e.g. Georgiou et al. 2007), Sweden (e.g. Brandell & Staberg, 2008) and Italy (e.g. Guiso, Monte, Sapienza, & Zingales, 2008). In the research literature, it is frequently assumed that there is a problem regarding gender and mathematics. There are two sets of works from researchers investigating the issue of gender and mathematics. One set of works from researchers claims the existence of significant gender differences in

participation rates in mathematics education studies, and in related careers (e.g. Mendick, 2005b, 2008; Noyes, 2009). The other set of works from researchers argues that females' performance is significantly worse on average than males' is on mathematical tasks, activities, and examinations (e.g. Gorard, Rees & Salisbury, 2001). Therefore, I would like to question both of these aspects and discuss them individually.

2.3.1 Gender differences in participation in Mathematics

Girls and women's under-participation in mathematics and science is well known, as is the combination of historical, cultural, and educational forces that alienate women from carrying on with these subjects (Marr and Helme, 1990). Before The Education Reform Act of 1988 and the introduction of the National Curriculum in England, the study of mathematics was common for both genders with only few cases in some all-girl schools where females opted out of mathematics. After that, however, mathematics has been compulsory in maintained schools up to the age of 16. After the age of 16 all education is voluntarily, and this is perhaps the reason for gender differences in participation rates in mathematics post-16 (Burton, 1990).

Chipman (2005) indicates that in the early and mid-1970s the failure of women to enrol in studying mathematics was seen as a crucial obstacle to women's involvement in a broad range of high-status jobs. Leder (1990; in Fennema & Leder, 1990) points out that the extensive concerns about the educational needs

of women led to government funding, and special programs in order to improve educational provisions for them. Leder specifies that Women's Educational Equity Act and the Ford and Science Foundations in the United States granted funds, and some of the programs were the Projects of National Significance and the Participation and Equity programs in Australia. Leder also refers to the Cockcroft (1982) committee in the United Kingdom whose intentions were "to consider the teaching of mathematics in primary and secondary schools in England and Wales, with particular regard to mathematics required in further and higher education, employment, and adult life generally, and to make recommendations" (p. ix).

In the late 1970's, according to Cockcroft report (1982; quoted by Leder, 1990) data on the number of British men and women completing their mathematical degrees at the time revealed that out of an annual total of around 2500 graduates women made up less than 30% of the total. By 1989-1990 although this increased to around 58,000 annual graduates in mathematics sciences (including operational research, computer sciences, etc.), women still made up less than 35% of the total (DES, 1992; quoted by Walkerdine, 1998). According to DES (1992; quoted by Walkerdine, 1998) analogous, but not so obvious differences were also found in the school or college leavers (typically aged 18) who had obtained 2 or more General Certificate of Education Advanced level examinations (or 3 more Scottish Certificate of Education Higher grades) by subject combinations. More precisely, in 1989-1990, mathematics/science

combinations were achieved by 7% of females, but by 15% of males, and mixed results including mathematics were obtained by 21% of females, but by 30% of males. Statistics in the 1990's indicate that a lot of progress was made towards educational equity. Ernest (1994) points out that gender differences in enrolment for higher and more demanding mathematics courses, and for occupations that required a higher level of sophistication in the UK, were due to the attitudes of both males and females towards female success in mathematics. Therefore, male enrolment continued to be significantly higher.

Recent data show that participation in AS- and A-level mathematics in England has increased remarkably since 2004. Specifically, A-level entries among 16- to 18- year olds exceeded 53,000 in 2007 (OFSTED, 2008). However, according to OFSTED (2008) mathematics was boys' most popular subject at A-level in 2007. Statistics published by the Joint Council Qualifications (2011) show that in 2010 12.4% of boys took mathematics GCE A-level in comparison to 7.1% of girls. In addition, according to the Guardian (Anon, 2010a), a recent analysis of student numbers in 2010 showed that there has been no improvement in the uptake of women in mathematical sciences in higher education since 2000 - the proportion of women who take mathematical sciences in higher education remains stable at 38%.

In terms of Cyprus, statistical tables published by the Department of Statistics (2008/2009) from 1970 onwards show that there is a gap between male and

female students' participation in mathematics post-16 in public upper secondary schools-Lyceums (I should note that in Cyprus at the age of 15-18 students have the option to enter the second cycle of studies in secondary education, and although mathematics is compulsory for everyone, students at the age of 16 choose either advanced mathematics or common core mathematics). Specifically, in 1970, 20.8% of male students, opted for advanced mathematics compared to 9.6% of females (it should be noted that the remaining percentage of students chose courses within other streams of studies, for example classical studies that involved courses such as Greek language, Latin, history, common core mathematics, etc.). In 1980, there was a small improvement with 18.3% of male students opting advanced mathematics in comparison to 10.9% of female students. Ten years later, in 1990, according to statistics this gap still exists with 18.6% of male students, and only 11.4% of female students opting advanced mathematics. It is worth noting that between 1970 and 1990, the percentage of female students opting advanced mathematics slightly increased, whereas the percentage of male students opting advanced mathematics decreased.

During 1995 to 2000, the Unified Lyceum was launched on a pilot project basis in three schools in Cyprus in order to offer both general and technical/vocational education. In the academic year 2000-2001, the restructured Unified Lyceum was established on a pancyprian scale to replace the Lyceum system of optional subjects that functioned before for over twenty years (Ministry of Education and Culture). The statistics published by the Statistics Department in Cyprus

(2008/2009), show that in 1999 the year before the establishment of the Unified Lyceum in all upper secondary schools in the Southern part of Cyprus, the gender gap in terms of male and female students' participation in advanced mathematics courses although it got smaller was still evident with 19.3% of males and 14.6% of females opting for advanced mathematics. However, there is no statistical information available by the Department of Statistics in Cyprus (2008/2009) to indicate gender differences in participation rates in advanced mathematics since the establishment of the Unified Lyceum.

2.3.2 Gender differences in Mathematics performance and achievement

Gender differences in mathematical performance are found mostly by data collected from students' tests, whereas gender differences in mathematical achievement are found by data collected from standardized mathematical tests (e.g. GCSE). During the 1970s, researchers were making a lot of effort at documenting gender differences in performance in mathematical tasks and tests (e.g. Fennema, 1974; Fennema & Sherman, 1977). Fennema (1974) summarized the facts with respect to mathematics achievement patterns at the middle of that decade as follows:

“No significant differences between boys' and girls' mathematics achievement were found before boys and girls entered elementary school or during early elementary years. In upper primary and early high school years significant differences were not always apparent. However, when significant differences

did appear they were more apt to be in the boys' favor when higher-level cognitive tasks were being measured and in the girls' favor when lower-level cognitive tasks were being measured." (p. 137)

There are a number of explanations for differences in mathematical performance and achievement given by Shuard (1981; quoted by Walkerdine, 1998) and both Primary and Secondary APU surveys (1980a and 1980b; quoted by Walkerdine, 1998). These explanations are listed by Walkerdine (1998, p. 27) as follows: boys are significantly better on test items requiring 'spatial ability'; boys are better at more complex items requiring abstract thought, problem solving, breaking set, conceptualization; and girls are better at simple, repetitive tasks requiring low-level skills such as rule-following. According to the large-scale Assessment of Performance Unit primary surveys (APU, 1985 and 1991; quoted by Walkerdine, 1998) there were quite a few significant differences in mathematics performance between 11-year-old male and female students. For instance, in two categories concerning measures the success rate was in favour of boys. The only area girls had a higher success rate was that of algebra. The differences between 15-year-old male and female students in the 1987 APU (1991) were even more obvious. Precisely, 41% of male students got a pass in the national mathematics examinations at age 16 in 1987, whereas only 34% of female students passed.

Since 1987, the gender differences in test results in the UK have reduced. By the mid-to-late 1990s girls in England doubled the amount of improvement in their

rates of examination success compared to boys and equalled and to some extent did better than boys in their overall exam success in the national GCSE examinations in mathematics at age 16. On the other hand, there were still areas that girls were poorer achievers than boys such as at GCE A-level mathematics for 18-year-olds in the UK. According to the statistics, in 1993 more girls achieved grades A-C, by 0.4%. However, a greater number of boys obtained grades A and B, by 18% (Dean, 1994; quoted by Walkerdine, 1998). Recent data show that girls are outperforming boys in A-level and AS-level mathematics. The percentage point gap between male and female students in A-level and AS-level mathematics is greater than that observed at GCE level in England, Wales, and Scotland. In 2001-2002, 96% of males obtained grades A-E in A-level mathematics compared to 97% of females (source: Gender and Innovation Statistics). More recently, according to the Guardian (Anon, 2010b) in 2010, in mathematics GCSE 58.4% of entries received a C (57.0% in 2009). Boys outperformed girls for the second year in a row (but not by much): 58.6% of boys' entries scored C or above, compared to 58.3% for girls.

In terms of Cyprus, there is no statistical information available from large-scale surveys conducted in Cyprus to indicate gender differences in mathematics performance and achievement. One possible reason for that might be that the differences in achievement between male and female students in Cyprus who take mathematics are insignificant or minimal, and therefore have not created the concern of education researchers, educators, or policy makers. A study by

Georgiou, Stavrinides, and Kalavana (2007) that involved 255 eight-grade students from 10 randomly selected public junior high schools (six situated in urban and four in rural areas) from the major Nicosia district in Cyprus, showed indeed that there were no significant differences between male and female students in mathematics achievement. These findings were based on data collected through a questionnaire that measured students' attributions of their own mathematics achievement and their attitudes towards the subject, a mathematics achievement test, and a questionnaire (which was administered immediately after the students completed the mathematics test) measuring the students' affective reactions to the mathematics achievement test.

Some further information about students' achievement in Cyprus is provided by TIMSS (Trends in International Mathematics and Science Study) studies (1995; 1999; 2003; 2007). TIMSS, which is the largest international comparative study, conducted every four years by the International Association for the Evaluation of Educational Achievement (IEA), measures trends in students' mathematics and science achievement. The aim of this study is to help countries all over the world improve students learning in mathematics and science. The study involves educational achievement data collection at the fourth and eighth grades (with the exception of the first TIMSS study in 1995 which involved data collection at other grades as well) to provide information about trends in performance over time together with extensive background information to address concerns about the quantity, quality, and content of instruction. TIMSS projects have influenced the

development and (re)design of mathematics and science curricula in a number of countries (Robitaille, Beaton, & Plomp, 2000).

Information from TIMSS 1995 study indicates that for the third, fourth, seventh, and eighth grade Cypriot students there was no statistically significant difference in mathematics achievement between male and female students. It is worth mentioning also that in TIMSS 1995 study, Cyprus was one of the five participating countries (the other four countries were Greece, Australia, Italy, and Slovenia) with the minimal and insignificant gender gaps in achievement among the twelfth graders taking advanced mathematics. Additional information from TIMSS 1995 study indicates there were no statistically significant differences between third and fourth grade students in Cyprus and England in terms of their achievement in mathematics. On the other hand, statistical comparisons between seventh- and eighth-grade students in Cyprus and England showed that the mean achievement of Cypriot students was significantly lower than the mean achievement of English students. Statistical comparisons, however, between twelfth-grade Cypriot and English students' mathematics achievement are not available.

TIMSS 1999 study also showed that there were no statistically significant differences between eighth grade male and female Cypriot students in terms of their achievement. Additional information indicates that there were no statistically significant differences between eighth-grade Cypriot and English students on

their average achievement in mathematics. On the other hand, TIMSS 2003 study showed that there was a statistically significant difference between eighth-grade male and female Cypriot students' achievement in mathematics with female students having a higher score than male students. A statistically significant difference in mathematics achievement was also found between fourth-grade male and female students with male students having a higher score in mathematics than female students. Further information indicates that the average achievement in mathematics of the fourth- and eighth-grade Cypriot students was significantly lower than the average achievement in mathematics of the fourth- and eighth-grade English students.

Lastly, TIMSS 2007 study showed a statistically significant difference between eighth-grade male and female Cypriot students' achievement in mathematics with the female Cypriot students having a higher score than the male Cypriot students. It is interesting that recent TIMSS studies reveal statistically significant differences in mathematics achievement between fourth- and eighth-grade male and female Cypriot students that were not existent before. What is most interesting though is that at the fourth grade these differences favour male Cypriot students, whereas at the eighth grade they favour female Cypriot students. It is very likely that female Cypriot students' outperformance in mathematics at eighth-grade relates to their choices of taking advanced mathematics later on, and pursuing studies in mathematics related fields at

university level. However, this is only an assumption and in-depth examinations are needed to confirm this.

2.4 Explaining gender differences in Mathematics participation and achievement

There is no doubt of the complexity of the issue of gender differences in mathematics. Researchers have been proposing various explanations as to why there are gender differences in mathematics participation, performance, and achievement. These explanations include varied and multi-level complex individual internal-related factors (such as cognitive and affective characteristics), and external environment-related factors (such as family, school, and society) whose influences change in character and importance across the life course (Byrnes, 2005; Ceci & Williams, 2007; Halpern et al. 2007).

As I mentioned in Chapter 1, girls in Cyprus tend to choose mathematics and mathematics-related fields at university level more often compared to girls in England (e.g. Department of Statistics and Research, 2009; Francis, 2002; Smithers & Robinson, 2006). Therefore, of primary interest of this study was a deeper understanding of possible factors that may influence the attitudes towards mathematics of girls in Cyprus and girls in England. These factors may provide an insight into how attitudes are related to girls' enrolment in advanced level mathematics, and their intentions to continue enrolment in mathematics and mathematics-related courses in higher levels. For this comparative study, culture

is likely to play a significant role. Sociocultural approaches emphasise the social basis and organisation of affective and cognitive experience. Therefore, socio-constructivists view affect as primarily grounded in and defined by the social context (Op't Eynde et al. 2006). This study views students' attitudes towards mathematics as a socio-cultural construct embedded and shaped by the context in which it develops.

Thus, in order to understand gender differences in participation in mathematics, and mathematics-related careers between students in Cyprus and England identified earlier, the present study adopts a socio-cultural explanation where the internal factor studied is students' attitudes towards mathematics and their relationship to external environment-related factors, in particular to parents and teachers (as perceived by the students). Indeed, Andreescu, Gallian, Kane, and Mertz (2008) drawing on data from different mathematics competitions pointed to the influence of socio-cultural and environmental factors on students', and especially females' willingness to carry on studying mathematics at university level, and thus to have the option of following careers in mathematics and related fields.

2.4.1 Internal-related factors – Affective factors

A learner himself/herself plays a significant role in any process of learning (e.g. Schoenfeld, 1992). Whether one is interested in, motivated to, confident enough to learn something, depends on how one perceives his/her own ability, self-

image, and self-motivation in addition to other external factors (e.g. Hannula, Majjala, & Pehkonen, 2004). As a result, this will have an effect on how one responds to learning the subject. Consequently, in learning mathematics we would have expected the learner himself/herself to influence to some degree his/her own attitudes towards mathematics.

Socio-cultural explanations have called attention to affective factors as they are considered important in influencing course enrolments (e.g. Dick & Rallis, 1991; Eccles, 1994; Kyriakou & Goulding, 2006), and mathematics achievement (e.g. Ercikan, McCreith, & Lapointe, 2005; Estrada, 2002; Kloosterman & Coogan, 1994; Leder, Pehkonen, & Torner, 2002). A theoretical approach within psychology provides some understanding into the relationship between affective factors, achievement, and course enrolment in specific substantive areas. Eccles and her colleagues (Eccles, 1994; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005) have proposed and tested an “expectancy-value” theoretical model to explain gender differences in mathematics achievement and the underrepresentation of women in careers in mathematics, science, and engineering. This theoretical model emphasizes that achievement in specific domains, such as mathematics and science, and the development of specialised knowledge are themselves short-term goals that individuals consciously work towards. Achievement-related goals, such as course selections in schools, career aspirations, persistence on difficult tasks, and the allocation of time and effort on many activities, are directly influenced by the individual’s perceptions of

importance or value of a specific task and by the individual's expectations of success. The individual's perceptions of importance or value of a task are influenced by cultural norms (e.g. stereotypes about a specific school subject), and his/her short-term and long-term goals (e.g. thinking of taking advanced mathematics or becoming a mathematician). In addition, the individual's expectations of success are influenced by the individual's aptitudes and past experiences (e.g. grades in the subject), his/her interpretations, and attributions of these experiences, and his/her self-concept of ability. Furthermore, parents' and teachers' attitudes, expectations, and stereotypes can have an impact on individuals' self-concept and attitudes towards the subject. Eccles (1994) expectancy-value theoretical model has received a lot of empirical support (e.g. Eccles, 1994; Frome & Eccles, 1998; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005), and offers a clear model for why cultural inequalities in educational and occupational opportunities have an unfavourable effect on girls considering careers in mathematics-related fields.

The affective variables identified in the literature as strongly implicated in explaining gender differences in mathematics participation and achievement include attributions of success and failure in mathematics, confidence, mathematics anxiety, enjoyment of mathematics, perceived usefulness of mathematics, fear of success, motivation, and perceptions of mathematics as a male domain. These affective variables will be discussed in detail.

2.4.1.1 Attributions of success and failure in mathematics

An affective variable that is considered significant in the literature on gender differences in mathematics participation and achievement is the way in which students attribute causation for success or failure. Attributions theory is concerned with how individuals assign meaning to observed events and how this relates to the way they think and behave (Bar-Tal, 2000; Nenty, 1998; Nenty and Polaki, 2005; Reyes, 1984; Weiner, 2004). Although Heider (1958) was the first to propose a psychological theory on attribution, Weiner and his colleagues (e.g. Jones et al. 1972; Weiner 1974, 2004) developed a theoretical framework that has become a major research paradigm of social psychology. Weiner (1974) focused his attribution theory on achievement and identified ability, effort, task difficulty, and luck as the most significant factors affecting attributions for achievement.

Weiner (1974, 2004) indicates that success or failure can be attributed to either personal internal forces such as individual ability or effort, or situational external forces such as difficulty of the task or luck. He goes beyond this internal-external dichotomy, however, to suggest that these attributions vary in terms of expected stability or invariance. Specifically, he indicates that ability and task difficulty are perceived as relatively stable, whereas luck and effort are perceived as being quite unstable. For instance, if a student attributes his/her failure to lack of ability, then he/she will have little reason to expect that he/she will succeed in the future, since ability is stable. However, if a student

attributes his/her failure to effort this does not prevent his/her success in the future, since effort is unstable and can be controlled by the student in order to make success possible in the future. Similarly, if a student attributes success to his/her ability has every reason to expect success in the future since ability is a stable characteristic. On the other hand, if the student attributes his/her success to luck, cannot expect to succeed in the future since luck is unstable. Many studies have found small, but consistent gender differences in the attributional patterns of learners for their performance in mathematics. Boys more often than girls attribute their successes in mathematics to stable factors such as task difficulty or ability, whereas girls attribute their successes in mathematics to unstable factors, such as effort, luck, and good teacher (Bartal, 2000; Eccles et al. 1986; Lightbody et al. 1996; Nenty, 1998). In fact, a study in England by Lightbody, Siann, Stocks, and Walsh (1996) which involved 1068 secondary school students who completed a questionnaire concerned with enjoyment of school, enjoyment of subjects, and students' attributions to academic success showed that girls rated hard work and teachers' liking for the student to be more important than boys did. On the other hand, boys rated cleverness, talent, and luck to be more important.

Georgiou, Stavrinides, and Kalavana's (2007) study mentioned earlier which involved 255 eighth grade (14-year-old) Greek-Cypriot students from 10 junior high schools in Nicosia examined students' attributions of mathematics achievement and their attitudes towards mathematics (how attractive and

useful mathematics was) using a questionnaire. Students also completed a test of mathematics achievement (this test was constructed based on the released items of the original TIMSS assessment of mathematics in eighth-grade children) as soon as they completed the attitudes and attributions part of the questionnaire. Immediately afterwards students reported their affective reactions towards the test by completing a questionnaire measuring their affective reaction to the mathematics examination. Georgiou, Stavrinides, and Kalavana found no significant differences between boys and girls in actual mathematics achievement (this was tested by comparing boys' and girls' mean scores). In order to test possible differences in the attitude, attribution, and affective reaction factors they created four groups as follows: boys with high achievement, boys with low achievement, girls with high achievement, and girls with low achievement. The criterion used to create these groups was that high achievement was operationally defined as any score that was higher than one standard deviation above the mean of the total distribution of scores, while low achievement was operationally defined as any score lower than one standard deviation below the mean of the total distribution of scores. After performing ANOVA (one-way analysis of variance), they found that high achieving boys had a significantly higher mean score in ability attributions than all the other groups. However, high achieving girls did not have significantly higher mean score in effort attributions than high achieving boys. In addition, their study showed that high achieving boys had significantly higher attitude (attraction) towards mathematics only in comparison to low achieving boys

and girls, but not in comparison to high achieving girls. Moreover, Georgiou, Stavrinides, and Kalavana (2007) report that high achieving boys and girls expressed positive affective reactions after taking the mathematics test, whereas low achieving boys and girls expressed negative affective reactions after taking the mathematics test.

Lloyd, Walsh, and Yailagh's (2005) study compared the mathematics report card grades, 2001 Foundation Skills Assessment (FSA) Numeracy subtest scores, performance attributions, and self-efficacy of 62 fourth-grade and 99 fifth-grade students in British Columbia. They found that girls' achievement in mathematics met or exceeded that of boys', and girls' attributional patterns were more self-enhancing compared to those of other studies reviewed. On the other hand, girls were found to be under-confident compared to their actual mathematical achievement, and when they were compared to boys they were more likely to attribute failure in mathematics to lack of teacher's help.

Other studies investigate attribution patterns for males and females in mathematics in order to understand why more males than females opt for advanced mathematics courses. For example, a study by Pedro, Wolleat, Becker, and Fennema (1981) using the Mathematics Attribution Scale (MAS) developed by Fennema, compared attribution patterns with achievement scores for 647 female and 577 male high school students enrolled in college preparatory algebra and geometry classes in 10 high schools in the United

States. In terms of attribution patterns, Pedro et al. (1981) study revealed quite a few gender differences. Precisely, their study showed that female students, more often than male students, attributed their success to effort. On the other hand, male students attributed their success to their ability more strongly than the female students did. They also found that female students attributed failure experiences in mathematics more strongly than the male students did, to lack of ability or to the difficulty of the task. Other gender differences were also found when they made comparisons of the subscales with gender and achievement scores. At all levels of achievement, more female than male students were attributing their success to their efforts. However, as females' achievement level was increased, the degree to which they attributed success to their effort decreased. Adding to this, they found that for both male and female students, the attribution of success to ability increased as achievement increased and the attribution of failure to low ability decreased as achievement increased.

In the same study, Pedro et al. (1981) used achievement data, attribution scores from the MAS, and other attitudinal data as predictors of students' plans to take high school mathematics. Entering achievement as a control variable in the first step of a stepwise multiple regression, they found that for both male and female students enrolled in algebra the score for attributing success to ability was significantly related to plans to take more mathematics. For female students enrolled in geometry, the score attributing failure to ability

was also significantly related to plans to take more mathematics. Pedro et al. (1981) study shows that attributions of success or failure in mathematics can be particularly interesting not only because such attributions can indicate students' future choices, but also because they can portray students' understanding of past events.

Eccles (1987) advocates that women's underrepresentation in certain high-level and scientific careers are due to psychological factors and suggests that the way girls attribute their success in mathematics courses may be the cause for not taking mathematics further. Eccles (1986) and her colleagues conducted a series of longitudinal studies of the ontology and socialization of precollege students' achievement beliefs, attitudes and behaviours. Among other findings, they found that boys and girls of approximately equivalent mathematics ability have a different perception of what causes their success and failure in mathematics and this may lead them to different decisions regarding future prospects for success in mathematics courses. For example, girls who regard consistent effort as a more important determinant of their success in this year's mathematics course might have lower expectations of success for next year's mathematics course because they assume that future mathematics courses will require even more effort for success than this year's mathematics course.

2.4.1.2 Confidence

Confidence, which has generally been accepted as a belief about one's competence in mathematics, has been identified as one of the most significant affective variables, influencing students' approach to new material including a determining factor of their persistence (Becker, 1984; Burton, 2001; Ireson, Hallam and Plewis, 2001; Myers, 2000; Rogers, 2003). Meyer and Koelher (1990) maintain that confidence is one part of self-concept. To them a confident student is someone who is certain of his/her ability to learn new mathematics and do well in mathematical tasks, and someone who is willing not only to approach new material but also to persist when the material becomes difficult. They strongly believe that confidence in mathematics is reflected by continued participation in mathematics course taking and career aspirations in mathematics-related fields. Reyes (1984) also supports this view: "confidence in one's ability to learn mathematics appears consistently as a strong predictor of mathematics course election" (p. 562).

Some extensive work on the variable of confidence and its relationship to gender differences in mathematics is found in the Fennema-Sherman studies (Fennema & Sherman, 1977, 1978; Sherman & Fennema, 1977). These studies involved both male and female high school students from the United States. Specifically, the Fennema-Sherman study in 1977 involved 589 female and 644 male (mainly white) ninth- to twelfth-grade students from four schools in the United States enrolled in mathematics courses, and the Fennema and Sherman study in 1978 involved 1320 sixth- to eighth-grade students in the

United States who were enrolled in additional mathematics classes. One of the intentions of Fennema-Sherman studies was to collect data concerning the relationship between eight affective variables, including confidence, and mathematics achievement, and to document gender differences in these relationships. In order to do that, Fennema and Sherman used the Fennema-Sherman Mathematics Attitude Scales, which they produced in 1976. These attitude scales consisted of a subscale measuring confidence. Fennema and Sherman also gave students a mathematics achievement test. According to their findings when a gender difference in mathematics achievement was found in favour of male students, it was accompanied by a gender difference in confidence also in favour of males. These gender differences in students' confidence existed even when there was no difference in achievement. Their studies also showed that at both middle and high school levels, female students reported lower level of confidence in their ability to learn mathematics, than male students did.

Confidence was also studied in relation to gender differences in mathematics participation. Armstrong and Price's (1982) study involved a national investigation in the United States in order to identify the relative importance of several factors (such as sex-role stereotyping, career and academic plans, attitudes towards mathematics, parental influence, and influence from significant others) that might be affecting women's participation in mathematics. Their sample consisted of high school seniors. After performing

a number of correlation and regression analyses in order to evaluate predictive models for participation, Armstrong and Price (1982) found that positive attitudes towards mathematics, parental and significant others positive influences, and perceived need for mathematics future career and educational plans, had the strongest relationship to participation. In relation to confidence in learning mathematics, they found that female students considered this variable as the second most important variable, after perceived usefulness of mathematics, whereas male students considered it as the third most important variable. It is worth mentioning that one of the intentions of this study was that its findings could be used in suggestion of intervention programs aimed at increasing females' equity in mathematics.

According to Leder (1995), the weight of evidence in the United States suggests that women are less confident than men are about their mathematical ability, and therefore less likely to persist on difficult tasks. They are also more ambivalent about the value of mathematics as an occupational requirement. Gender differences in students' confidence in mathematics were also found in studies in England. For example, Rogers (2003) in examining students' study approaches to key stage 4 GCSE assessment, found that girls were significantly less confident in their ability than boys. Rogers' (2003) findings are supported by Ireson, Hallam, and Plewis' (2001) study that examined the effects of structured ability grouping on students' self-concepts. This study involved over 3000 Year 9 students in 45 mixed secondary comprehensive schools in England who

responded to a multidimensional self-concept scale measuring academic and general facets of the self-concept, and showed that boys had a higher perception of their mathematical abilities than girls did even when they were of similar academic attainment. A study however by Mendick (2005a), challenges Rogers' (2003) and Ireson's et al. (2001) findings. Mendick (2005a) when interviewing 42 male and female students aged between 16- and 19-years-old and one mature student in England who were opting for advanced mathematics, found no differences between them in terms of their confidence in their mathematical abilities. Only four of the 43 students who were interviewed self-identified as 'good at maths'. All four students were male and three were from the same further mathematics-teaching group. Mendick (2005a) argues that this identification was gendered not only because all three students were male, but also because the two female further mathematics students denied in their interviews the possibility of their being thought 'mathematical able'. Mendick explores the stories of those students who constructed themselves in the interview as 'good at maths' and suggests that this identification is the outcome of stories we tell about boys and girls. For example, stories in the press and other media about incompetent mathematicians, or stories that do not regard mathematical knowledge and skill as an adequate condition for enhanced power and prestige within western society, and stories of heroic mathematicians in films who in most cases are males.

2.4.1.3 Mathematics Anxiety

Mathematics anxiety or mathophobia as some like to call it has been the concern of many psychologists as well as educational researchers and it has been related to both students' decisions of taking mathematics at higher levels and students' achievement (e.g. Karimi & Venkatesan 2009; Kyriakou, 1997; Ma, 1999). Although many studies have been concerned with mathematics anxiety, a clear definition of mathematics anxiety is often hard to find, and therefore one might question how to recognise it. Green and Ollerton (1999) perhaps give the best definition of mathematics anxiety by explaining that mathematics anxiety is "a set of negative feelings towards mathematics arising from individuals' emotional responses to their experiences of school mathematics" (p. 43). According to Garry (2005), students who are maths anxious have little confidence in their ability to do mathematics and tend to take the minimum amount of required mathematics courses and this limits their career choice options. Kyriakou (1997) also indicates that anxiety can influence students' motivation and their experiences of anxiety may lead to students' opting out of mathematics related subjects. Moreover, Kyriakou (1997) explains that anxiety can affect students' cognitive ability as "awareness of being anxious takes up some of the 'mental space' available for information progressing" (p. 37)

Mathematics anxiety has been also related to students' achievement in mathematics. A meta-analysis by Ma (1999) examining 26 studies on the relationship between anxiety towards mathematics and achievement in mathematics among elementary and secondary school students showed a

significant relationship between them, this relationship was negatively correlated. In fact, a study by Karimi and Venkatesan (2009) which involved 144 male and 140 female 10th grade high school students from nine different schools in Karnataka state in India in order to evaluate the relationship between mathematics anxiety, academic hardiness, and mathematics performance, also showed a significant negative correlation between mathematics anxiety and mathematics performance. Specifically, this study by using a mathematics anxiety rating scale, an academic hardiness scale (an instrument designed to gather information about students' attitudes regarding academic success), and marks obtained by the students in the last class examination in the school in mathematics, showed that students who had high mathematics anxiety tended to perform low score in mathematics performance. On the other hand, those who had low mathematics anxiety tended to perform high score in mathematics. Their study also revealed a significant positive correlation between academic hardiness and mathematics performance. The correlation between mathematics anxiety and academic hardiness was not significant. In addition, Karimi and Venkatesan (2009) found that there were significant gender differences between boys and girls in mathematics anxiety, whereas there were no significant differences between boys and girls in mathematics performance and academic hardiness.

Paechter (2001) argues that “many pupils find the mathematics classroom an anxiety-provoking place” (p. 58) and suggests that girls in particular more often

than boys are said to have a phobia about mathematics and numbers. Indeed, Rogers (2003) confirmed this in a study that examined students' study approaches to key stage 4 GCSE assessment (see section on 'confidence' for more details). Rogers' study showed that girls were more anxious about mathematics examinations. However, according to Walkerdine (1998), studies of mathematics anxiety do not report consistent findings as there are few differences between male and female students. Only studies that examine 'extreme' anxiety show that more females than males are 'maths anxious'. Fennema and Sherman (1976) have noted a number of deficiencies in this approach and suggested that it is possible that men do not openly show their anxiety. They maintain that such an anxiety might have also arisen from being tested and from a lack of confidence in one's ability to learn mathematics. This, however, cannot always be the case. Boaler (1997) when examined girls' anxiety towards mathematics found that girls' anxiety was the result of the two different mathematical approaches that they had experienced in the two schools involved in her study, rather than the result of their own weaknesses. Others (i.e. Walkerdine, 1998) point out that anxiety cannot be separated from complex social processes.

2.4.1.4 Enjoyment of Mathematics

Some researchers indicate that mathematics is not a subject of pleasure for many students, and as such is likely to disaffection (Nardi & Steward, 2002, 2003; Robitaille et al. 1997). According to Williams and Ivey (2001), students

opt out of mathematics either because they are not interested in the subject, or because they find the subject boring. This was also supported by a study by Brown, Brown, and Bibby (2008) that showed that perceived dislike and boredom are important reasons for students not continuing with mathematics. Brown et al. (2008) used data from a Qualifications and Curriculum Authority (QCA) study evaluating the 2005 pilot and trial of new two-tier GCSE mathematics examinations (Stobart, Bibby, and Goldstein, 2005). The broader study involved a questionnaire that was given to students as soon as they had taken their GCSE examinations and before they had received their results. Brown et al. (2008) study was based on answers given by the students to a small part of the questionnaire that was not analysed as part of the main study. The participants involved were 1997 students in the GCSE cohorts from 17 schools across England and Wales. Of these participants, 1510 were predicted to get grades A*-C. Their study revealed that for students who were predicted to get grades A, B, or C the second and third most common reasons for not carrying on with mathematics were lack of enjoyment and a belief that mathematics was boring (the first common reason was difficulty of mathematics).

On the other hand, a QCA study carried out by Matthews and Pepper (2005) in England showed a relationship between enjoyment of mathematics and students' decisions for taking mathematics at advanced level. This study used both quantitative and qualitative sources of evidence such as national

examinations data, a large-scale questionnaire, and a sample of case study centres involving teachers and students in order to provide a comprehensive picture of take up and participation in mathematics at A level. The students involved in this study were AS and A2 students, A level students who had dropped out from GCE mathematics courses, and A level students who gained good grades in mathematics at GCSE. The study showed that 40% of female students choosing GCE mathematics rated enjoyment of mathematics as most important reason compared to only 25% of male students. The study also showed that 22% of male students and only 12% of female students felt that career was a key reason for choosing GCE mathematics. Moreover, the study revealed that for those students who dropped GCE mathematics enjoyment of mathematics was linked to teaching (the same applied for AS and A2 students). A group of the students indicated that they had not enjoyed GCSE because they had been 'poorly taught', the teaching focussed on how to 'pass the exam' and they could not see the worth of the coursework.

2.4.1.5 Perceived usefulness of Mathematics

Another important affective variable is the perceived usefulness of mathematics study and the resulting mathematical knowledge. Meyer and Kohler (1990) indicate that this variable has been shown to be strongly associated with mathematics participation and achievement. They point out that as mathematics becomes optional and gradually more difficult for some students, it is unlikely that they will continue to engage in its study if they do

not consider it as useful. Pedro, Wolleat, Fennema, and Becker (1981) in their study discussed earlier, considered usefulness of mathematics as a predictor of students' plans to study high school mathematics. They found that prior achievement usefulness of mathematics was the strongest single predictor for both males and females. Chipman (2005) also indicates that among the NIE (National Institute of Education) grant studies in the United States the general perceived usefulness of mathematics was fairly related to participation, whereas specific perceptions of mathematical requirements for an intended job or career aspirations for higher education had a rather stronger relationship to participation or participation intentions. Chipman maintains that by 1998-2000 in the United States gender differences in high school mathematics participation had almost disappeared and women had become the majority among BA recipients. However, there are still gender differences in mathematics-related fields such as engineering, physics, and computer science. Chipman concludes that for women, the primary usefulness of mathematics study in high school may be meeting the requirements for admission to the college of their choice rather than the essential requirements of their work-related choice.

2.4.1.6 Fear of success

Horner (1968; quoted by Meyer and Koehler, 1990) was the first who suggested that fear of success was a useful variable in explaining gender differences in studies on achievement motivation. According to Horner (1968),

fear of success is the fear (held mostly by women) of the negative outcomes that go along with success. When Leder (1982) studied the relationship between fear of success, mathematics performance, and course taking intentions for both male and female secondary school students in the United States, she found that for high-achieving male students, high fear of success was associated with their intention to leave school or not to take further mathematics courses. On the other hand, high-achieving female students with high fear of success expressed intentions of taking two additional mathematics courses. Adding to these, Leder's (1982) study showed no relationship between high fear of success and high mathematical performance for males. Some of the female students, however, who were performing well in mathematics were also likely to be high in fear of success, but for some others being high in fear of success was incompatible with continued high performance in mathematics. Based on this finding, Leder suggested that the female students in the latter group in order to resolve their conflict would have to either lower their performance in an attempt not to appear so successful, or opt out of continued mathematics study. Nevertheless, fear of success does not seem to offer a convincing overall explanation for gender differences in mathematics. The key of understanding its role might be its interaction with other variables such as social factors.

Indeed, Caplan and Caplan (2005) argue that girls who perform well in mathematics often fear being ostracised by peers because femininity in many

societies is described as inconsistent with mathematical ability. Thomas (1990) explains this argument by suggesting that subjects construed as 'hard, certain and concrete' (p. 109), as mathematics often is, are closely related to people's constructions of masculinity. Ernest (1995) advocates that a prevalent public image of mathematics is that "is difficult, cold, abstract, theoretical, ultra-rational, but important and largely masculine" (p. 449). Jones and Smart (1995) also propose that there has been a move from the view that girls are failing mathematics to one that they are opting out of a subject that is seen as "masculine" and "divorced from social issues" (p. 157).

2.4.1.7 Motivation

According to Bomia et al. (1997) motivation is "a student's willingness, need, desire, and compulsion to participate in, and be successful in the learning process" (p. 1). Motivation has been often viewed as reasons students have for behaving in a given situation (e.g. Middleton & Spanias, 1999). Motivation has also been distinguished in the literature as intrinsic (arising by interest in the subject being studied) and extrinsic (depending on the availability of external rewards) (e.g. Ryan and Deci, 2000). Others distinguish three motivational orientations in educational settings: learning (or mastery) orientation, performance (or self-enhancing) orientation, and ego-defensive (avoidance) orientation (e.g. Lemos, 1999; Linnenbrink and Pintrich, 2000). In addition, according to Murphy and Alexander (2000) motivation can be

conceptualized by interest (situational vs. individual), and self-schema (agency, attribution, self-competence, and self-efficacy).

In mathematics education motivation has been discussed under the terms motivational orientation (Yates, 2000), interest (Bikner-Ahsbahs, 2003) and motivational beliefs (Kloosterman, 2002). For example, Malpass, O'Neil, and Hocevar (1999) study in the United States that involved mathematically gifted mainly Asian American high school students examined the effects of gender, self-efficacy, learning goal orientation, self-regulation, and worry on high-stakes mathematics (i.e. an advanced placement calculus exam) using a structural equation modelling framework. Their analyses revealed a positive relationship between self-efficacy and mathematics achievement, a moderate and positive relationship of self-efficacy and self-regulation, and a high and negative relationship between self-efficacy and worry. In addition there was a positive relationship between learning goal orientation (or intrinsic value), and self-regulation and worry, but there was no relationship between learning goal orientation and self-efficacy or high-stakes mathematics achievement. Other findings also showed that boys were less worried and had higher self-efficacy for mathematics than girls had, and self-regulation was negatively related to worry. However, it was not related to high-stakes mathematics achievement.

Researchers who study motivation suggest a model of achievement goal theory in which students' achievement goals are embedded in numerous socio-cultural

contexts and are formed by past and present experiences in those contexts (Friedel et al. 2007). In addition, researchers provide considerable evidence of instructional practices that promote students' motivation (Anderman et al., 2002). These instructional practices are similar to the ones proposed by mathematics educators to achieve both learning and motivational outcomes (Stipek et al., 1998). In fact, Pantziara and Philippou (2009) study that involved 321 sixth grade students and their 15 teachers in order to examine endogenous (students' motivational constructs), and exogeneous factors (teachers' practices) that influence students' mathematical performance, revealed that mastery goals had a statistically significant effect on students' performance. Moreover, regarding the environmental factors examined in this study, mother's education emerged as significant in influencing students' performance. It should be noted that students' data were collected through a questionnaire that included six Likert-type scales measuring motivational construct and a test measuring students' performance in fractions. Teachers' practices, on the other hand, were collected via an observational protocol.

2.4.1.8 Perceptions of Mathematics as a male domain

The low participation of women in higher mathematics, science, and technology has been the concern of many researchers for many years, and in order to understand it they offer different theoretical positions concerning gender. For example, Harding (1986) introduced three forms of gender: individual, symbolic, and structural. Individual gender refers to the construction of a gender identity.

Symbolic gender refers to images, words, and thoughts about males and females. Structural gender refers to labour division in paid and unpaid work according to gender. These three forms of gender are inter-reliant, and Harding considers them as always asymmetric: “Femininity is constructed to absorb everything defined as not masculine and always to acquiesce in domination by the masculine” (p. 50). Harding argues that many intervention projects based on affirmative action simply fail to notice the influence of a society showing a strongly gendered workforce, of the values attached to what is viewed as male and female domains, and of the symbolic gender in science itself.

Gender differences in favour of boys that have been systematically observed in mathematics achievement for many years have created gender-stereotype beliefs such as “girls are not good at mathematics”. Mathematics-related gender stereotypes are likely to deter girls from performing well in or carrying on with mathematics (e.g. Eccles, 1987), and when they are made prominent then is girls’ performance on mathematics exams that suffers the most (e.g. Spencer, Steele, & Quinn, 1999). In order to explain gender differences in performance in mathematics research, Steele and Aronson (1995) introduced the “stereotype threat” effect. This effect emerges when there is a negative stereotype about a particular group, which then undermines that group’s performance (Aronson & Steele, 2005; Steele 1997; Quinn and Spencer, 2001; Smith and White, 2002). It has been suggested that if girls are put in a mathematical test situation together with boys this can have an effect of lowering girls’ performance and when the

stereotype threat is high then girls are less able to formulate problem-solving strategies (Smith and White, 2002). Stereotype threat theory suggests that if the threat is strong then the effect will be stronger (Inzlicht & Ben-Zeev, 2000). Others argue (e.g. Fennema, 2000; Tiedemann, 2000a) that is parents' and teachers' gender stereotypes that affect children the most, and the influence of both of them is exercised on children through the messages that they are sending to them that usually differ according to the child's gender. This stereotypical thinking not only from the adults' part but from children's part as well contributes to gender differences in achievement and participation in mathematics and mathematics-related fields (Leder, 1992; Walkerdine, 1998).

The concept of mathematics as a male domain was introduced by Fennema and Sherman (1976). Mathematics as a male domain subscale has been used widely to assess the extent to which mathematics is stereotyped as being masculine. Fennema and Sherman study (1976) showed that gender differences were non-existent or insignificant with the exception of mathematics as a male domain scale. Both girls and boys who participated in Fennema and Sherman study perceived mathematics a male domain, with boys however holding much stronger views. These findings were confirmed in a number of studies during the years to come particularly in the United States. One of these studies was a study by Hyde (1990) and her colleagues. Hyde et al. (1990) in a metastudy analysed results from 70 articles describing examinations concerning attitudes towards mathematics mainly using the Fennema-Sherman scales. Their study showed

that the mathematics as a male domain (the MD) scale was the only attitude scale for which gender differences were significant. Specifically, boys that participated in this study viewed mathematics as a male domain to a greater extent than girls did. Using statistical methods, the researchers also examined whether gender differences varied with time and age of the participants. They concluded that gender differences were diminished to some extent from the 1970s; however, they were still significant in the 1980s. Hyde et al. (1990) expressed concern that:

“[Males’ stereotyped views] might lead male peers of female students to indicate in a variety of subtle ways that females who achieve in mathematics are somehow less feminine and thus put pressure on females not to achieve in mathematics. Such views might also lead male teachers to discourage girls from taking mathematics courses or might lead male employers or job interviewers to discourage female applicants for mathematics-related jobs.” (p. 310)

Even though the gender differences found by Hyde and her colleagues were small, the researchers advised against dismissing the effects of affective variables on gender differences in mathematics learning outcomes:

“The stereotyping of math as a male domain may be critical to females’ willingness to achieve in mathematics. It may indicate a pervasive belief

throughout much of society, which females sense and find difficult to overcome.” (p. 312)

Another study that showed that perceptions of mathematics as a male domain exist was a study by Andre, Whigham, Hendrickson, and Chambers (1999). Their study that took place in Iowa involved elementary school students and their parents who completed related attitude and belief questionnaires about school subjects. One of the findings was that students perceived jobs related to mathematics or science more male dominated. In addition, a study by Greene, DeBacker, Ravindran, and Krows (1999) that involved 366 high school students in the United States who completed a questionnaire consisting of a subscale measuring mathematics as a male domain showed that “for both males and females, endorsing the stereotype that mathematics is a male domain was negatively related to reported effort” (p. 456). Therefore, it seems that perceptions of mathematics as a male domain persist to be related to students’ mathematics motivation and achievement.

Brandell and Staberg (2008) investigated whether Swedish secondary school students (age 15- and 17-years-old) perceived mathematics as a female, male, or gender-neutral domain and examined gender and age differences in attitudes. This study involved both quantitative and qualitative data. The principal means for data gathering was a new instrument ‘Who and Mathematics’ which is an attitude scale developed by Forgasz, Leder, and Gardner (1999). The total

number of students who answered the questionnaire was 750 in Year 9 (in compulsory school) and 550 in Year 2 in the social science (SS) and the natural science (NS) programmes at upper secondary school (school Year 11). After a preliminary analysis of the responses to the questionnaire, a series of interviews followed with about 50 students.

The data from Brandell and Staberg (2008) study were analysed with respect to gender, school year, and study programme. The results showed that students in Year 9 perceived mathematics to a certain extent as a male domain, and it was more pronounced in theoretical programmes in Year 11. Positive aspects of mathematics were associated with boys. Mathematics was seen to be more important for future work for boys showing the awareness of a structurally gendered labour market. Boys were often perceived to like challenging problems. These attitudes were pronounced by younger and older pupils, and by male and female students. The older students also perceived mathematics as more easy, interesting, and enjoyable for boys. Negative aspects of mathematics were perceived as more female. Students in Year 11 perceived girls to be more likely to find mathematics boring and difficult. This view, however, was not supported by all subgroups. The male students from the NS programme perceived girls as the ones who had difficulties with mathematics, while this was not the case for the male students from the SS programme or from Year 9. The same difference did not show between the female students' subgroups. Moreover, both the

questionnaire and the interview showed that the younger students perceived that girls worked better compared to boys, and were more diligent.

Other studies also examined gender-stereotype perceptions of mathematical ability. Overall, male students have been found to believe that their mathematical abilities were superior to those of females. Specifically, this has been found among primary (e.g. Forgasz, 1992; Tiedemann, 2000a), junior secondary (e.g. Forgasz, 1995) and upper secondary students (e.g. Jacops, 1991). Female students also have generally considered male students to be superior but not to the same extent as male students. For example, Meyer and Koehler (1993) found that more males were picked to be successful with a mathematics problem by grade 6 boys than by grade 6 girls. Forgasz and Leder (1996) also asked grade 9 students in Australia to write whether they believed men or women were better at mathematics and to explain their answers. Most of the students indicated that men and women were equally proficient. Among those who expressed a gender-stereotyped view, a larger proportion of the female students perceived women to be better at mathematics (9%) than perceived men to be superior (2%). The pattern was reverse for male students, 23% perceived men to be better at mathematics and 13% considered that women were superior.

2.4.2 Environment-related factors

According to Oakes (1990), gender differences in mathematics performance entail differences in three domains: opportunity, achievement, and choice. After

reviewing the literature of relevant sociological research, Oakes concluded that females' educational opportunities in mathematics and science were restrained by gender role socialization and this resulted in their poor performance in mathematics tests and limited their interest in mathematics. Oakes argues that the reason only a small number of women choose careers in scientific and technical fields, is their low achievement levels and their inadequate interest in mathematics. Epstein (2001) points out that there are three social areas, which can have an effect on students' opportunities, achievement, and choices and strengthen gender-stereotyped socialization prototypes. These social areas are family, school, and community.

2.4.2.1 Family and social background influences on gender differences in Mathematics

Many researchers (e.g. Kleanthous & Williams, 2009; Silverman, 1991; Tocci & Engelhard, 1991; Vryonides, 2007; Walkerdine, 1998) emphasise the strong influence of family on students' academic success and career choices. The home environment is seen as a fundamental factor in the early development of mathematical concepts and educational outcomes (Carr et al., 1994; Peters and Jenks, 2000). Walkerdine (1998) also stresses the responsibility of mothers to create an environment that will allow their children at an early stage of age to separate from them. Walkerdine maintains that this will enable their children to become independent and autonomous and will result to their educational success.

Parental influences on students' mathematics learning are often categorised in the literature into two categories: direct assistance and indirect assistance (Cai et al., 1997). Direct assistance such as helping children with mathematics difficulties and helping children with mathematics subject choice was found to have less important impact on students' mathematics performance (e.g. Cai et al. 1997; Wang et al. 1996). Indirect assistance, such as parental encouragement, parental expectation, and parents' attitudes towards mathematics were frequently identified as having a significant impact on students' attitudes towards mathematics, students' participation in advanced level mathematics, and students' achievement in mathematics (e.g. Ma 2001; Wang et al. 1996). Parsons et al. (1982) proposed that there were two processes involved in parental influence: parents as role models, and parents as expectancy socialisers. According to Parsons et al., the former assumes that "models, parents in particular, exhibit behaviours which children imitate and later adopt as part of their own behavioural repertoire." (p. 310). The latter, on the other hand, suggests that parents influence their children's achievement through expectations as "parents may convey their expectations in the messages they give regarding their beliefs about their children's abilities, and the difficulty of various achievement tasks." (p. 311).

A study that shows that parental encouragement and support can have a positive effect on students' learning and academic success is a study by Taylor (1990). This study, that involved interviews with eight mathematics professors and four

social scientists who received doctorates between 1976-1986 and have excelled in their teaching careers in the south-western United States, showed that education was extremely valued in all the families of the participants. The parents of the participants not only encouraged but also supported their sons and daughters' education. They offered their children an environment where education was available, appreciated, and allowed them to develop and follow their own academic interests.

Ma and Kishor (1997) suggest that students' perception of their parents' support and perception of mathematics as a male domain can have an important impact on their mathematical achievement. Eccles (1994) also points out that parents who have traditional views on gender roles are more likely to appraise their children's abilities according to these stereotypes and offer their sons different learning opportunities than those they offer to their daughters. However, Muller (1998) when analysing national data of secondary school students in the United States, found that parental traditional views on gender roles did not reinforce gender stereotypes in mathematics achievement and concluded that parents might be the reason that the gender gap in mathematics learning activities is reducing. On the other hand, Muller's findings indicate that parental activities were associated with males and females' achievement test scores. Muller specifies that between grades 10 and 12 male students' achievement in test scores was strongly related with parental guidance and social control, whereas

female students' achievement in test scores was strongly linked to parental vocal communication and support.

Researchers also support that parents may have an impact on their children's attitudes towards mathematics and career choices. For example, Tocci and Engelhard (1991) found that parents are among the most influential groups indicated in the literature that shape their children's attitude. Catsambis and Suazo-Garcia (1999) also indicate that parental influence on students' attitudes and future plans is noticeable not only in their early school years, but also until their last year of high school. Others argue that the gender-stereotyped messages that parents may send their children can weaken girls' confidence in their mathematical abilities and limit their desire to pursue mathematics further. Jacobs' (1991) study in the United States, for example, involved 400 parents and their 6th to 11th –grade children who responded to questionnaires relating to their beliefs about their child's mathematics achievement, and their stereotypes about males' and females' relative abilities in mathematics. This study revealed that students' confidence in their mathematical abilities was more strongly related to parental expectations than to their mathematical performance, and that parents' expectations of their daughters and sons were influenced by whether they considered mathematics to be a male domain. Zeldin and Pajares (2000) also when interviewed women with mathematics-related careers in the United States found out that their self-efficacy (beliefs in their abilities) in mathematics and career decisions in mathematics-related occupations was strongly related to

significant others having confidence in their abilities and expressing this confidence to them.

The link between parental support and gender-stereotyped perceptions in regards to mathematics is also evident by the role that mothers' occupation seems to play on female students' pursuit of mathematics-related careers. In fact, a multi-university study of students leaving mathematics and science majors by Seymour and Hewitt (1997) in the United States showed that female students' pursuit of mathematics-related careers was associated with their mothers being employed and the type of their profession. The importance of significant others support particularly for female students' attitudes and career choices is emphasized by many others (e.g. Clewell & Anderson, 1991).

However, parental influence might be mediated by social capital and the ways parents use cultural models to communicate their desires to their children. In fact, a cross-cultural study by Kleanthous and Williams (2009) that involved students from both Cyprus and England investigating their dispositions to study further mathematics in higher education, revealed cultural differences in the ways students perceived parental influence. Specifically, findings from this study revealed that perceived parental aspirations (the degree to which parents value education and urge their children to do well in school and the strength of the parents' expression of the importance of their children's social advancement through education) had no statistically significant effect on Cypriot and White

British students' dispositions to study further mathematics. In addition, evidence from the qualitative data indicated a subtle parental influence often 'denied' for both Cypriot and White British students. However, for ethnic minority students in England there was a statistically significant effect on students' dispositions to study further mathematics. The interviews also revealed that ethnic minority students tended to say that they were strongly motivated by their family.

Researchers also support the view that parents' socioeconomic background plays an important role in students' learning and success. Papanastasiou (2000) argues that students' success in most academic subjects is predicted by their socioeconomic status, which is undoubtedly as he points out the most significant background characteristic. Papanastasiou maintains that gender differences are non-significant and sometimes non-existent among middle-class students. Hoover-Dempsey and Sandler (1995) also indicate that children whose parents are well educated and economically privileged have more learning opportunities both at home and in school because their parents have more information on how the school works and are more comfortable communicating with the school staff. This was also supported by Useem's (1992) study, which involved interviews with 86 mothers in two suburban communities in the United States. Useem's study showed that parents of higher SES were able to negotiate with school staff about the mathematics placement of their children, placing them in higher-ability groups than they were originally allocated. According to this study, college-educated

parents are more concerned and prone to interfere with their children's placement and decisions.

2.4.2.2 School influences on gender differences in Mathematics

Another significant domain influencing gender differences in mathematics is the school environment. According to Catsambis (2005), gender differences in mathematics are initially obvious in students' attitudes in the middle grades. Catsambis points out that variation in mathematics-related attitudes is related with developmental changes in gender identity. Catsambis maintains that during the early teenage years when females begin to establish their feminine identity, they become more vulnerable to social strains that weaken their self-confidence and performance in mathematics and science. Research that already exists in this area has focused on three general aspects of the schooling experience: a) organizational characteristics of schools and classrooms; b) social interactions within the school (between students and teachers, or among students themselves); and c) methods of assessment and curriculum content. Sociologists are focusing mostly with the first two aspects of schooling experience (Catsambis, 2005); however, I will discuss all three aspects in detail.

(i) Organizational characteristics of schools and classrooms

Catsambis (2005) indicates that researchers have been mainly focusing on social influences within the classroom and to a less extent on organizational features of schools. However, few organizational characteristics have drawn substantial

amount of attention to both researchers and the public. In particular, the comparisons between public and private schools, and single-sex and coeducational schools have been debated in a big extent by many researchers. In the 1980s, Marland (1983) claims in his work that in certain cases in the UK single-sex schools showed less noticeable sex stereotyping. Specifically, according to the 16+ and 18+ UK national examination results, girls from single-sex schools were engaged in more stereotypical subjects (such as mathematics and science) and did better than girls from coeducational schools. In addition, more boys from single-sex schools succeeded in English literature and foreign languages than boys did from mixed schools. Marland maintains that subject choice was less stereotypical in single-sex girls' schools than in coeducational schools.

In the United States Bryk, Lee, and Holland (1993) analysed relevant data of high schools students and found that students attending Catholic schools had higher test scores in mathematics than those students attending public schools. Riordan (1990) also indicates that within the Catholic school zone, single-sex school students were obtaining higher test scores in mathematics than coeducational school students. Adding to this, girls in single-sex Catholic schools not only did more homework, but also enrolled in more mathematics courses and did better in mathematics test scores than the girls from Catholic coeducational schools. These findings are also in line in terms of Australia. Mael (1998) indicates that girls' performance in mathematics and science in Australia is higher in single-sex

schools compared to girls' performance in coeducational schools. Mael after reviewing the literature regarding single-sex and coeducation points out that the students who attend public and private schools are different in fundamental ways that make it practically impossible to determine whether these differences in test performance between the two categories of schools are due to the school environment or to pre-existing differences of their students. He specifies that students attending private schools are of higher socioeconomic statuses, and students in Catholic schools are socially and culturally more homogeneous than those attending private schools. Mael concludes that there is some evidence for the view that single-sex schools may benefit girls in subjects such as mathematics and science; however, single-sex education may not always contribute to equity in education because gender biases are present in single-sex schools.

On the other hand, Marsh (1989) showed that the transition from single-sex to coeducational high schools had no effect on the size of gender differences in mathematical achievement. Marsh's study involved 2,332 Catholic high school students in Australia attending one of 47 single-sex or 33 co-educational schools included in the nationally representative High School and Beyond (HSB) study. This study aimed to make comparisons between the effects of single-sex and coeducational high schools and achievement, attitudes, and behaviours, and to determine whether attending single-sex schools affected well-established gender differences in these variables. Marsh when examined the effects of school type,

gender, and their interaction on senior year outcomes and postsecondary activities after controlling for variables measured during the sophomore years, found that changes in a broad variety of outcomes during the sophomore-to-senior period were nearly unaffected by school type. Changes in many of these outcomes were associated to gender. However, these gender differences were almost unaffected by school type.

Single-sex classes, is another school practice often found in the literature relating to gender. According to Jackson (2002), the purpose of single-sex classes is to improve the learning experiences of either male or female students. Jackson maintains that Government members suggested that schools which are unable to offer single-sex classes to try to implement 'boy-girl' seating arrangements in some classes instead. One can argue though that this might cause a strained situation where none of the students would enjoy their lessons, and therefore have a negative effect on both male and female students' learning. Jackson, however, refers to a school in England that used single-sex physics classes and found that the A-level uptake increased considerably.

Spielhagen (2005) study that took place in a middle school in the rural Hudson Valley of upstate New York that offered voluntary single-sex classes in language arts, mathematics, science, and social studies to its 6th, 7th, and 8th grade students showed that single-sex class arrangement appeared to be more effective when offered as optional to parents and students. In order to conduct

his study, Spielhagen involved both interviews and observation of students (a combination of 6th, 7th, and 8th grade students) and interviews with parents. His classroom observations showed that the students seemed more lively, more focussed, and on-task in single-sex classes. In addition, 50% of the students that were interviewed expressed that they could concentrate more in single-sex classes, with the female students giving feedback that was more positive. Another study in England that confirms female students' positive responses to single-sex classes is a study by Jackson (2002). Jackson's study involved a co-educational school in England with students attending single-sex mathematics classes. After administering a questionnaire, Jackson found that 80% of the female students stated to be more confident in single-sex classes, 65% of them claimed that such classes helped their progress, and 55% indicated that they had more enjoyment in single-sex classes. On the other hand, Jackson's study showed that the same did not apply for the male students who overall reported negative effects. It is worth noting that Jackson's findings were based on only one school, and therefore they may not be representative of the whole population of students. Fennema (1996) advocates that if male and female students seem to succeed more by being taught separately, then the reason might be that male and female students learn differently.

Besides single-sex and coeducation schooling, ability grouping is a further school practice that is associated with gender differences in mathematics. Catsambis (1994) indicates that female high school students benefit in mathematics ability

groups in comparison to their male classmates. Catsambis, Mulkey, and Crain (2001) used in their study national data from the United States in order to investigate whether middle school ability grouping in mathematics had an effect consistently on the social-psychological attributes and school-related behaviours of male and female pupils. They found that the effects of mathematics ability grouping were different between male and female students. Specifically, they indicate that high-ability male students who were in middle schools and were divided in ability groups had lower self-esteem and educational ambitions. On the other hand, low-ability males were advantaged from the mathematics ability grouping. Mathematics' ability grouping affected girls in a smaller degree. Catsambis, Mulkey, and Crain concluded that high-ability girls were affected in a positive way by mathematics ability grouping; however, low-ability girls were affected in a negative way.

In another study that took place in the UK, Boaler (1997) conducted a detailed investigation of two schools which were using totally different ways of teaching mathematics (in one of the schools students were taught using 'chalk-and-talk' methods, whilst on the other the students were working on open-ended projects) but the student intakes were more or less alike. Boaler followed a year group of students as they moved from Year 9 to Year 11 (300 students in total from both schools). In order to make comparisons of the two different mathematical approaches used by the schools, Boaler conducted ethnographic three-year case studies of the mathematical environment in the two schools. As part of these

case studies, she carried out a longitudinal cohort analysis of each year group of students in each school. One of the findings of Boaler's study was that features of the learning environment disadvantaged many of the English students in high ability groups. Specifically, she found that while many middle class boys attained higher grades in GCSE than would be expected given their prior attainment, many girls and working class students of both genders did less well than expected, and often felt anxious in lessons. Boaler related the negative consequences of being taught in 'top set' groups to the highly procedural approach to teaching that is typical for these classes, and to the continued fast speed at which students were required to work.

A small scale study by Boaler, William and Brown (2000) that took place in the UK investigating the ways in which students' attitudes towards, and achievement in mathematics were influenced by ability grouping as they moved from Year 8 to Year 9 found that the setting provided a slight gain in pupil attainment for top set pupils. However, they concluded that setting promotes a considerably more rigid curriculum and inflexible styles of teaching than in mixed ability classes. The authors suggested that this could have a bad effect on students' attitudes and motivation at both upper and lower levels. Adding to this, they suggested that, in practice, grouping ability may reduce teachers' expectations of children in lower ability groups, while creating unrealistic high ones of the learning processes of the children in the top levels.

An aspect of school organization that has equally concerned researchers in terms of gender equity in education is school teachers' characteristics. According to Oakes (1990), female teachers in the United States are mostly found in the elementary grades. Oakes maintains that the number of women in authoritative positions such as principals and school board members is considerably smaller in comparison to that of men. Moreover, more men than women teach mathematics and science. This, however, does not apply for Cyprus. According to the Department of Statistics and Education in Cyprus tables (2008/2009), more women than men are head teachers not only in primary but also in secondary schools. In England during the academic year 2008-2009 according to Curtis (2009), the percentage of women head teachers in secondary schools increased to 44% from 31% the year before. Although 70% of head teachers in primary schools are women, men are statistically more likely to be head teachers than classroom teachers. This suggests that the rather few men who work in primary schools tend to be in senior management positions. Catsambis (2005) indicates that the lack of appropriate role models for girls and same-gender teachers, who will support their pursuits in non-stereotypical fields, has an effect on both their efforts to do well in mathematics and their interest in the subject. However, there is not much research to support this view.

Another view is that the beliefs teachers hold about male and female students can have an impact on gender differences in mathematics. According to Tiedemann (2000b), teachers hold different perceptions about male and female

students' abilities in mathematics. Forgasz (2001) maintains that teachers believe that average-achieving girls are less talented compared to average achieving boys, and consequently girls have to exert more effort than boys in mathematics. Therefore, teachers usually tend to attribute girls' failure to low ability, whereas boys are believed to have flair in mathematics (Fennema et al. 1990; Walkerdine, 1998). Indeed, after Elwood (2005) had discussions with mathematics teachers in England, it was stated that teachers and examiners often attribute girls' successes not to their "brilliance but to hard work and industry; success which by this definition is finite and limited" (p. 382).

This is in line with findings from a study by Fennema, Peterson, Carpenter, and Lubinski (1990) that involved 38 first-grade female teachers in 24 schools in the United States and examined their beliefs in relation to gender and mathematics. The teachers who participated in the study were asked to identify their two most and least successful male and female students in mathematics, to attribute causation of these students' successes and failures, and to describe their characteristics. Teachers' choices of most and least successful students were then compared to mathematics test scores of their students. A careful analysis of the data showed that teachers' beliefs about male and female students in mathematics were different. Teachers perceived male students as being their best students and were most inaccurate when selecting most successful male students. In addition, they tended to attribute male students' success in mathematics to ability more often than they did for female students, whose

success was attributed more often to effort. Moreover, teachers perceived their best male students when compared to their best female students as more competitive, more logical, more adventurous, more independent in mathematics, volunteered answers more often to mathematics problems, and enjoyed mathematics more.

Fennema (1990) states about teachers stereotyping of mathematics:

“ . . . while there is no conclusive evidence that teachers believe that mathematics is more appropriate for males than for females, wherever evidence exists, it indicates that teachers tend to stereotype mathematics as a male domain. Such stereotyping results partially in differential treatment of males and females in classrooms and undoubtedly influences the development of gender differences in mathematics.” (p. 181)

Fennema (1990) generalizes that:

“ . . . while there is not always conclusive data about teachers' beliefs in relationship to female, males, and mathematics, when data are available they indicate that teachers' beliefs are somewhat negative about females and the learning of mathematics . . . there are some negative consequences of what could be interpreted as negative teacher beliefs.” (p. 184)

Teachers' attitudes and practices may also produce gender differences in mathematics. According to Fennema, Carpenter, Jacobs, Franke, and Levi (1998) teachers' attitudes and practices may result to gender differences in skills such as problem solving that may be critical for high achievement in advanced mathematics where the gender gap still exists. They indicate that male students usually employ different strategies when solving mathematical problems in comparison to girls. Male students become autonomous learners in mathematics and insist in solving complex tasks more often than girls do. In addition, according to Fennema et al. (1998) male students tend to exert independence and to be creative when they solve mathematics problems, whereas female students tend to follow standard problem-solving procedures. These gender differences in problem-solving approaches may have as an outcome even bigger gender differences in later years and could possibly explain why the gender gap in mathematics performance persists among high-achieving students. Fennema et al. (1998) conclude that because male students' are inventive while solving mathematical problems can master mathematics that is more advanced.

Another view is that teachers' gender may influence students' attitudes. A study by Mallam (1993) that used data from a stratified random sample of 240 female students from five coeducational and six all-girls' secondary schools in Nigeria showed that there was a significant difference between the attitudes towards mathematics of female students taught by female teachers. When Mallam considered both variables (school type and teacher gender), he found

out that the highest proportion of female students expressing positive attitudes towards mathematics was found in all-girls secondary schools where mathematics was taught by male teachers. These findings were in line with findings from Lee and Lockheed's (1990) study that involved 1,012 Nigerian ninth grade students from 40 single-sex and coeducational schools in Nigeria. Their study showed that female students taught by female teachers had positive attitudes towards mathematics.

(ii) Social interactions within the school

The way teachers interact with male and female students may have an impact on gender differences in mathematics. Sadker, Sadker, and Klein (1991) argue that male students receive more attention (both positive and negative) and are supported and encouraged more by their teachers compared to female students. Indeed, Leder (1990) in a study that took place in Australia and involved observation of mathematics classrooms in fourteen schools found that boys more often than girls received more attention from their teachers because the boys were seen to ask more questions and make more work-related elicitations. It is argued in the literature that teachers' tendency to give more attention to boys than girls is due to the dominance of boys in the mathematics classroom. A quantitative study in Papua New Guinea by Sukthankar (1998) that involved 400 students revealed that 78% of the students agreed that male students dominated the mathematics classroom discussions and that they were encouraged to do so by their teachers. This study also showed that 65% of the students felt that male

teachers gave more attention to male students, and 78% of female students felt that this had an impact on their performance. Surprisingly, however, 85% of the male students felt that their verbal dominance did not have an impact on female students' performance, whereas 67% of the female students felt disadvantaged reporting "always" feeling dominated by male students in the classroom (Sukthankar, 1998, p.99). Sukthankar's study sadly does not give any information on how male students' domination of discussion in the mathematics classroom was encouraged by the teachers, or in fact how the students perceived their teachers' encouragement.

Fennema (1996) commends on teachers' differential treatment of boys and girls in the mathematics classroom by suggesting that this "differential treatment of boys and girls is merely a symptom of many other causes of gender differences in mathematics" (p. 74). She argues that treating the symptom is not as adequate as treating the cause and suggests that it is essential to examine what is causing this different treatment of boys and girls by teachers. As Leder (1990) suggested in her study discussed earlier, teachers' differential treatment of boys and girls in the mathematics classroom perhaps is caused by boys' behaviour (i.e. asking more questions) and their work related elicitations in the classroom. Equal treatment and encouragement of boys and girls in the mathematics classroom by their teachers can have a positive impact on their attitudes and help towards eliminating gender differences in mathematics participation and achievement. Indeed, Zeldin and Pajares (2000) argue that teachers' encouragement is

extremely significant particularly for female students as it can develop their positive attitudes towards mathematics. Zeldin and Pajares (2000) after analysing 15 narratives of personal stories of women who selected and continue to do extremely well in careers in areas of mathematics, science, and technology found that almost all of them perceived their teachers as being supportive for their mathematical pursuits.

Apart from interacting with their teachers at school, students also interact with their peers. Leder (1990) indicates that peers are considered very important for young people's socialization, and perpetuate gender-role differentiation through gender-typed activities during students' free time, friendship patterns, school subject preferences, and career pursuits. Sadker and Sadker (1995) argue that from the middle grades on, peers affect students' mathematics related interests and performance. They maintain that teenage people's vulnerability to peer pressures usually strengthen stereotypical gender behaviours. On the other hand, Zeldin and Pajares (2000) argue that when female students have encouraging peers who are also friends, and are interested in mathematics and sciences then they engage more with mathematical activities and perform better in mathematics-related subjects.

(iii) Methods of assessment and curriculum content

Methods of assessment and curriculum content have also concerned researchers in terms of gender differences in mathematics achievement and

participation. For example, the effects of mathematical coursework on male and female students' participation in mathematics has been questioned by Elwood and Comber (1996) and the Qualifications and Curriculum Authority (QCA) proposed that the tiered examination structure can result to teachers focusing their encouragement for progression to AS level mathematics at top sets only (QCA, 2005).

According to Boaler (1997), the introduction of mathematics coursework at GCSE (which has now been removed from GCSE specifications) had led to the mathematics curriculum emphasizing largely the development of mathematical thinking. It is believed though those female students were advantaged more than male students were by coursework, since it allowed them to implement their preferred learning styles of more collaborative working (Elwood, 2005). However, it can be argued that this was limited since the coursework element contributed to only 20% of the final mathematics GCSE result. Indeed, Elwood (2005) by considering statistical results demonstrated that coursework had less weight than the examination on the final GCSE grade. In addition, Elwood showed that the GCSE results of female students tended to be influenced less than the GCSE results of male students by coursework. Elwood explained this contradiction by suggesting that there was often less variation in the marks awarded to female students than those awarded to male students. Hence, Elwood proposed that if coursework marks were gathered together and examination marks were spread then it is the

examination mark that has more of an influence in deciding the student's final grade. However, a conclusion like this would be supported completely if this analysis of coursework marks was conducted over a number of years. It is also possible that Elwood's findings would change from year to year. For instance, female students' coursework marks obtained during one year might have shown more variation than boys and consequently reversing Elwood's conclusion. What should someone also have in mind is that Elwood's conclusion was based on coursework generally and was not a mathematics specific observation.

The QCA project into students' participation in mathematics by Matthews and Pepper (2005) discussed earlier, that involved national examinations data, a large-scale questionnaire, and a sample of case study interviews with teachers and students, showed that some students were positive about mathematics coursework because they found it easier than examinations. On the other hand, some other students indicated that they did not enjoy coursework, as it did not always relate to GCSE topics and made suggestions of the reduction or even abandonment of the coursework requirement at GCSE. These students also indicated that they were put off by the coursework to progress to AS level mathematics.

ACCAC (Awdurdod Cymwysterau Cwricwlwm ac Asesu Cymru /Qualifications, Curriculum, and Assessment Authority for Wales) (1999), after following

statistical analyses of statutory assessments between 1992 and 1997, found some noticeable links between forms of assessment and gender, suggesting that male students do better on short examination style questions, whereas female students perform better in extended writing tasks. This can possibly support the suggestion that coursework is more appropriate for female students as it usually involves extended writing tasks. The findings from ACCAC (1999) are challenged, however, by Boaler (1998). Boaler's study that involved case studies with students at two schools in England showed that both male and female students preferred their coursework lessons where they were free to work on their own coursework, which involved extended mathematical thinking, and writing rather than quick questions. It is worth noting though that ACCAC (1999) considered students' achievement, while Boaler focused upon students' preferences. A possible explanation for the existing difference between ACCAC's work and Boaler's study could be that although the male students preferred coursework lessons they did better on short style questions.

The National Curriculum of England, Wales, and Northern Ireland that was introduced in 1989, following the Education Reform Act of 1988, has been often criticised for having negative effects on students' learning of mathematics that can consequently influence their attitudes. For example, Pickering (1997) argues that: "the introduction of the National Curriculum took away the opportunity for schools and students to specialise in areas of study

more relevant and interesting to them” (p. 79). Burton (2001) thinking of the mathematics curriculum in particular elaborates on Pickering’s argument by suggesting that the curriculum is “fragmented” and “disconnected” and students are expected to memorise rules and then “regurgitate” these in examinations (p. 66). Burton’s conclusion about the mathematics curriculum is based on a study that she carried out in four schools in England where she interviewed thirty 16-year-old students in order to find out their reasons for rejecting mathematics.

Burton (1995), in a previous publication, after reviewing the literature explained that the mathematics curriculum resulted in teachers feeling that certain topics must be taught at certain times, not pertinent to students’ knowledge and that particular methods must be learnt with no more explanation other than they just have to be learnt. Burton’s view is based on the assumption that students have to achieve specific expected targets and in order to achieve them the work must be covered in a planned, rigorous manner with little consideration of the individuals. Orr (2000) though points out that modifications, such as the introduction of General National Vocational Qualifications (GNVQs) for 14- to 15-year-olds, to the National Curriculum increased to some extent the flexibility of curricular planning, and therefore may diminish the rigid structure of the curriculum.

2.4.2.3 Community influences on gender differences in Mathematics

There are various factors of the wider social environment, which can have an effect on children's education (Crane, 1991). These influences become stronger during the teenage years when young people become more independent and spend more time outside their homes (Steinberg, 1998). Many researchers consider neighbourhood as a factor that can affect children and particularly teenagers (Aneshensel & Sucoff, 1996; Brooks-Gunn et al. 1997a, 1997b; Crane, 1991). Besides, to socioeconomic disadvantage, the poorest neighbourhoods are inclined to experience institutional disinvestment and to have higher rates of racial segregation, unemployment, residential instability, financial reliance, and female-headed households (Bursik and Grasmik, 1993; Bryk, Lee, and Holland, 1993; Sampson, 2000, 2004; Wilson, 1987). These characteristics are related to several educational and behavioural outcomes, including infant mortality, teenage childbearing, low academic achievement, educational failure, and crime (Brooks-Gunn et al. 1997a; Sampson, 2000). Young people's behaviours can be influenced in a negative way by the social context of disadvantaged neighbourhoods. This is because of high incidence of undesirable behaviours (Crane, 1991), low quality or lack of local organisations such as high-quality schools and recreation centres (Bryk, Lee, and Holland, 1993; McLaughlin, Irby, and Langman, 1994), or low levels of social control in public space (Bursik and Grasmik, 1993).

Indeed, a study that explains the process of by which neighbourhood context influences social behaviour is a study by Sampson, Raudenbush, and Earls (1997). Sampson et al. (1997) studied Chicago neighbourhoods using statistical techniques of Hierarchical Linear Modelling and systematic observation, and identified collective efficacy as a significant characteristic of neighbourhood context. It should be noted that collective efficacy refers to working trust and shared engagement for action by the neighbourhood residents in local social control (Sampson, 2004). Neighbourhoods that are extremely disadvantaged are likely to have low levels of collective efficacy, which results to social disorder, deviance, and crime (Sampson & Raudenbush, 1999). Consequently, the context of many poor, inner city neighbourhoods may involve a source of behavioural risk and an educational disadvantage for young people.

In addition, children from disadvantaged neighbourhoods may experience very limited effective parental practices on their academic performance (Catsambis & Beveridge, 2001; Sampson, 2000). According to Sampson and Raudenbush (1999) low levels of collective efficacy, inadequate resources, and a high number of children from single-parent families may add additional difficulties to the supervision of children and adolescent peer groups. It has been actually revealed that a great number of extremely poor families influence negatively the quality of learning environments at home (Brooks-Gunn et al., 1997a) and particularly African American families that are segregated in disadvantaged

neighbourhoods influence negatively their children's academic achievement (Dornbusch, Ritter, & Steinberg, 1991).

In fact, children from minority groups are especially vulnerable to neighbourhood disadvantages, because they are more often segregated in disadvantaged neighbourhoods compared to children from white groups (Dornbusch et al., 1991; Massey & Denton, 1993). A study by Gonzales, Cauce, Friedman & Mason (1996) in Seattle that examined the influence of family variables (family income, parental education, family structure), parenting variables (maternal support and restrictive control), peer support, and neighbourhood risk on the school performance of 120 African American junior high school students, showed significant interrelationships between neighbourhood characteristics, parental practices, and peer relationships. Specifically this study revealed that for teenagers living in low-risk neighbourhoods, supportive relationships with both mothers and peers were linked to higher school grades. On the other hand, for teenagers living in high-risk neighbourhoods only restricted parental control was linked to higher grades in school. Gonzales et al. (1996) concluded that the social climate of high-risk neighbourhoods where many African American teenagers live weakens the positive effects of parent-child and peer relationships on students' academic achievement.

A study by Catsambis and Beveridge (2001) showed that the social characteristics of disadvantaged neighbourhoods are not only associated with teenagers' negative behaviours, but also with students' mathematical performance in standardised tests (mathematical achievement). Their longitudinal study in the United States of America involved a large-scale examination of middle school students, their parents, and schools. Catsambis and Beveridge (2001) after comparing the mathematics test scores of eighth-grade students who lived in neighbourhoods with different social characteristics, they found that students who lived in disadvantaged neighbourhoods had lower mathematics test scores compared to those students from more socially advantaged neighbourhoods. Another finding of their study was that the link between students' achievement in mathematics and some parental practices such as everyday communication with their children, close observation of children's activities and extra learning opportunities offered to the children, was stronger for students lived in disadvantaged neighbourhoods than those lived in socially advantaged neighbourhoods. However, Catsambis and Beveridge (2001) study did not examine whether there were any similarities or differences between male and female students regarding their mathematical achievement when neighbourhood characteristics are taken into consideration.

Sadly, research on the possible effects of communities and neighbourhoods on the gender gap in mathematics is almost nonexistent. There is one study,

however, by Entwisle, Alexander, and Olson (1994) which indicates that neighbourhood characteristics may influence gender differences in mathematics performance. Their study that took place in Baltimore and which involved a large random sample of young male and female students showed that the gender achievement gap broadened over the school summer break. Although neighbourhood effects were not examined directly by the researchers, the researchers suggested that this gender gap might be due to parents encouraging their sons more than their daughters to explore and take advantage of neighbourhood resources and learning opportunities.

Another significant social influence on the mathematics gender gap is employment opportunities and the overall gender stratification in communities. Cunningham (2001) argues that young people's attitudes and ambitions can be formed by certain examples of occupational opportunities that they experience in their families and communities. Baker and Jones (1993) indicate that cross-national studies in the United States suggest that gender differences in mathematical achievement are associated to work-related gender stratification and postsecondary education. According to Baker and Jones (1993), young women's future goals in life are influenced by the prototypes of gender stratification they observe around them. They maintain that the reasons that discourage young women to carry on and do well with mathematics may be the traditional gender ideologies, and the limited opportunities offered to women regarding successful employment in

mathematics related professions. Subsequently, these social conditions may have a negative impact on parents' encouragement or help towards female students to engage in mathematics and science-related activities. Therefore, what is required is a legal system that will promote gender equity, offer employment opportunities in mathematics and mathematics-related fields, and encourage gender egalitarian ideologies in order to eradicate gender segregation in educational and occupational choices (Charles & Bradley, 2002).

An additional social influence that can have an effect on gender differences in mathematics is mass media such as television, radio broadcast, internet, newspapers, and published material. Communities and individuals are bombarded constantly with messages that promote not only products, but also moods, attitudes, and a sense of what is and is not important, and gender roles (Kenway & Bullen, 2001). All forms of media communicate images of men and women, many of which disseminate unrealistic, stereotypical, and limiting perceptions (Aksu, 2005; Davies, Spencer, Quinn & Gerharstein, 2002). Gerbner, Cross, Morgan, and Signorielli's (1993) study showed that individuals who spend a lot of time watching television compared to those who don't, believe that women have limited abilities and interests compared to men. In addition, their study revealed that heavy viewers expressed stereotypic views about what professions are more appropriate for women. Kimball's (1986) study also showed that after television was introduced to a

small community, the children's attitudes became more gender stereotypic reflecting those of children raised on television. Mendick, Moreau, and Hollingworth (2008) also indicate that most of the popular culture representations of mathematicians are male, White, middle-class, heterosexual and heroic.

Davies, Spencer, Quinn, and Gerharstein (2002) argued that exposure to gender-stereotypic commercials prime the female stereotype among men and women. Their three studies involved undergraduates (both men and women) at the University of Waterloo in the United States. In study 1, the participants who were enrolled in a second semester calculus course, were exposed to either a stereotypic or counterstereotypic set of television commercials (both sets of commercials contained six ads, four of which were neutral) prior to completing a lexical-decision task, and then a nondiagnostic mathematics test in order to elicit the female stereotype among men and women. Study 1 showed that exposure to the gender-stereotypic commercials activated the female stereotype among both men and women. However, only women for whom the activated stereotype was self-relevant underperformed on the subsequent mathematics test. In addition, it was revealed that level of stereotype activation among the female participants mediated the damaging effects of the television commercials.

Study 2 involved undergraduates (both men and women) at the University of Waterloo that were enrolled in an introductory psychology test. In Study 2, the mathematics test employed for Study 1 was replaced by an aptitude test in order to explore whether stereotype threat could lead women to avoid the domain of mathematics while looking for a domain in which they were immune to stereotype threat. In addition, the counterstereotypic commercials used in study 1 were replaced with neutral commercials. Study 2 revealed that women exposed to the neutral commercials did significantly better on the mathematics part of the exam than the verbal part. Exposure to the gender-stereotypic commercials, however, eliminated this mathematics-over-verbal performance bias. Furthermore, Study 2 showed that women in the stereotypic-commercial condition underperformed on the mathematics part of the test compared to women in the neutral-commercial condition.

Study 3 also involved undergraduates (both men and women) at the University of Waterloo who participated in an introductory psychology class. The same commercials used in Study 2 were again employed for the purpose of Study 3. After watching their allocated set of commercials, the participants completed a survey, which was asking them to indicate their current degree of interest in many educational and vocational choices. This study revealed that women exposed to the neutral commercials tended to express more interest in educational/vocational choices, which were vulnerable to stereotype threat (i.e. quantitative domains). On the contrary, women who were exposed to the

gender-stereotypic commercials expressed significantly more interest in fields, which were immune to stereotype threat (i.e. verbal domains). In addition, Study 3 revealed that women in the neutral-commercial condition expressed significantly more interest in quantitative domains than women in the stereotypic-commercial conditions did. This pattern of interest was reversed for the verbal domains, where women in the stereotypic-commercial conditions expressed slightly more interest than women in the neutral-commercial conditions did.

2.5 Summary of key points and conclusion

Before conducting this research project, it was essential to conceptualize attitudes towards mathematics. The intention of this study was not only to determine the degree to which students like mathematics, but also to find out their beliefs about mathematics and possible factors that form their attitudes (e.g. social factors). Therefore, the definition adopted for this study is that attitudes towards mathematics involve two components: a mixture of emotional responses (either positive or negative) such as liking/disliking of mathematics, anxiety towards mathematics, etc.; and beliefs which reflect a person's values and views and are based in one's past and present experiences that shape their behaviour (these beliefs include beliefs about the appropriateness of mathematics for males and females, the relevance of mathematics, etc.).

Studies reviewed in this chapter suggest that there are gender differences in participation rates in mathematics post-16, and gender differences in mathematics achievement and performance in both Cyprus and England. Gender differences in participation rates in mathematics post-16 in England are evident since the 1970's. Specifically, male enrolment for higher-level mathematics courses is significantly higher than female enrolment. In terms of Cyprus, similar differences in participation rates in mathematics post-16 were obvious in the 1970's, 1980's, and 1990's. Statistical information available from the Department of Statistics in Cyprus indicates, however, that the gender gap in mathematics participation became narrower in 1999. On the other hand, there is no statistical information available from the Department of Statistics in Cyprus for participation rates in mathematics in recent years. It is worth mentioning that although gender differences in participation rates in mathematics post-16 are evident in both Cyprus and England, girls in Cyprus more often than girls in England choose to study mathematics at university level (Department of Statistics and Research, 2009; Francis, 2002; Smithers & Robinson, 2006).

During the 1970s, researchers in England were also documenting significant differences in mathematics achievement that were evident after boys and girls entered elementary school. Since 1987, gender differences in mathematics test results in the UK have reduced. According to recent data girls are outperforming boys in A-level, and AS-level Mathematics. The percentage point gap between male and female students in A-level and AS-level Mathematics is greater than

that observed at GCE level in England, Wales, and Scotland (source: Gender and Innovation Statistics). In terms of Cyprus, TIMSS studies provide some information about Cypriot students' achievement in mathematics. Recent TIMSS studies (e.g. 2003, 2007) show a statistically significant difference between eighth grade male and female Cypriot students' achievement in mathematics, with female students having a higher score than male students.

Researchers (e.g. Brown et al. 2008; Elwood, 2005; Kleanthous & Williams, 2009; Zeldin & Pajares, 2000) proposed varied-multi level complex individual internal-related factors (such as cognitive and affective characteristics), and external environment-related factors (such as family, school, and society) to explain gender differences in mathematics participation, performance, and achievement. There is substantial evidence in the literature to support that there are gender differences in students' attitudes towards mathematics (e.g. Ireson et al. 2001; Karimi & Venkatesan, 2009; Lloyd et al. 2005; Rogers, 2003). Evidence in the literature also suggests that parental encouragement and support, and parents' attitudes towards mathematics have a significant impact on students' attitudes towards, and participation and achievement in mathematics (e.g. Ma, 2001; Wang et al. 1996). Parental influence might be mediated by social capital and the ways parents use cultural models to communicate their desires to their children (e.g. Kleanthous & Williams, 2009). The literature also supports that gender differences in mathematics are caused by the beliefs teachers hold about male and female students (e.g. Tiedemann, 2000b) and teachers' differential

treatment of boys and girls (e.g. Sukthankar, 1998). In addition, teachers' encouragement is considered extremely significant particularly for female students as it can develop their positive attitudes towards mathematics (e.g. Zeldin & Pajares, 2000).

In order to understand gender differences in participation in mathematics, and mathematics related careers between students in Cyprus and England, the present study adopts a socio-cultural explanation. The internal factor studied is students' attitudes towards mathematics and their relationship to external environment-related factors (such as parents' and teachers' influence as perceived by the students). Attitude in this study is considered as a socio-cultural construct influenced by the meanings that are made in different contexts. Comparisons of how attitudes are 'lived' in different contexts and cultures (or countries) can not only identify similarities and differences, but may also deepen our understanding of how social factors within different cultures (or countries) influence attitudes towards mathematics.

The attitudinal domains investigated in this study are: students' perceptions of the relevance of mathematics in their life now and in the future; students' enjoyment of mathematics, students' feelings of anxiety, students' attributions of success or failure in mathematics; students' confidence in their mathematical abilities; students' motivation; students' perceptions of their parents' expectations with regards to mathematics; students' perceptions of their mathematics

teacher's expectations; and students' perceptions of mathematics as a male domain or not.

Currently a comparative study of attitudes towards mathematics between high achieving students who take advanced mathematics in Cyprus and England is not existent. Therefore, in order to understand gender differences in participation in mathematics related careers my aim is to examine and compare male and female students' attitudes towards mathematics within and across the two countries, and explore possible factors (such as parents and teachers) that may influence and shape these attitudes. Therefore, the present study aims to provide a detailed analysis of the following questions:

1. Are there differences and/or similarities between students in Cyprus and England in terms of attitudes towards mathematics?
2. a) Are there differences between male and female students in Cyprus in terms of attitudes towards mathematics?
b) Are there differences between male and female students in England in terms of attitudes towards mathematics?
c) If there are, how do these differences compare across the two countries?
3. How do social factors influence the attitudes of male and female students in Cyprus and England towards mathematics?

I should note that these research questions were not determined from the beginning rather they were developed and refined based on the existing literature (Denzin & Lincoln, 2005).

Because the intention of the study was to compare the attitudes towards mathematics of male and female students within and across Cyprus and England, I considered important to discuss the culture of each country and the gender roles within each culture, and give some details about male and female students' educational choices within each country in the chapter that follows (Chapter 3). In addition, since students were selected from both Cyprus and England for the purpose of this study, I considered essential to describe in Chapter 4 the context in which students in Cyprus and England are educated.

CHAPTER 3

The Socio-cultural context of Cyprus and England

3.1 Outline of Chapter 3

In this chapter, I considered important to give some details of the socio-cultural context of Cyprus and England so that the readers have a better understanding of the gender roles within the Cypriot and English society. In addition, I briefly describe the gender and educational choices in each country so that one can have some knowledge on how educational choices vary by gender in each country, and how these choices are different between students of the same gender within countries.

3.2 The Cypriot society and gender roles

The social system of organisation in Cyprus is characterised as patriarchal (Hadjipavlou, 2004, 2006; Vassiliadou, 1997). For many decades, Cyprus has been an island in political conflict. Following a five-year anti-colonial struggle, Cyprus gained independence from Britain in 1960. Greek Cypriots (78% of the population), and Turkish Cypriots (18% of the population) struggled for power and representation in the fledgling government. Three years later and again in 1964 and 1967, violent conflicts erupted on the country. In 1974, a nationalist coup d'état (a sudden change of government by force) supported by Greece was followed by Turkey's invasion of the North part of Cyprus (Theophanous and Peristianis, 2011). Since then, the country has been de facto partitioned and this

meant institutions and elites, mostly men, overemphasized the “national problem”. As a result, women’s issues, such as women’s rights and gender equality, are marginalized as the national issue is prioritised over all other issues (Hadjipavlou, 2006).

According to research carried out by the Women’s Organisation of United Democrats (GOED, 2006) during the British period in Cyprus, women and girls were excluded from many opportunities. For example, in 1931 54% of Cypriots were illiterate- mostly women and working class men. In addition, young Cypriots aged between 15- and 19-years-old had not attended schooling, mainly girls (48%), and only some boys (17.1%). Anthias (1992) also indicates that girls learned early on to set marriage as the most important goal of their lives and the parents of girls had to provide a dowry. Men, on the other hand, were perceived to reach manhood when they married (nowadays it is believed that they reach manhood when they go to the army). Anthias maintains that in the power hierarchy of the family, men often believed they had the right to humiliate women or beat them up if they misbehaved. Additional information provided by research performed by GOED (2006) reveals that at a table, men and women had to sit separately, and the same applied in the church or mosque. Women also were not allowed to wear trousers or smoke, and should not drive a car. Moreover, according to GOED (2006), working-class women were working in the fields, but their husband or father was in control of their wages. Only a small number of

women were educated at secondary level, and had no say in public affairs or the right to vote. Women were reliant on men.

Persianis (1988) indicates that in the Cypriot traditional society women's social perception was closely associated with religion that demanded a woman be moral, completely loyal, and obedient to her husband. Persianis argues that this cultural perception of the role of women in Cyprus had an impact on women's schooling and how much education they should have. It was believed that if girls were educated this would mean delaying their 'natural destiny', which was marriage at a young age. Therefore, parents were only investing in their son's education. From the beginning of the century to the mid-1950s only girls from middle class families in Cyprus were educated; however if there were sons in the family they were the priority and had the advantage of further education, good employment opportunities, and travel abroad. Persianis sustains that the socialisation and education of boys and girls were gendered, and so was the school curriculum.

According to Persianis (1988), class stratification played a role in what women did and how much education they received or not received. For example, women's responsibilities in the cities were to be good wives and mothers, and if they had a job before their marriage, they had to stop afterwards so that they could be devoted to their husbands and children. On the other hand, in rural areas women not only had to do all the housework and caring for their family,

they also engaged in agriculture and farming. Therefore, they had double workload in comparison to that of working men. Persianis also indicates that women from the lower middle class often earned some money working as dressmakers, embroiderers, weavers, or handicraft makers in their homes. The money they earned provided them with an air of 'controlled independence'.

In 1960, Cyprus was semi-decolonised (still 99 square miles are sovereign British territory) and gained a 'qualified' independence. With the establishment of the independent Republic, women were given the right to vote (Vassiliadou, 1997). By the mid-1960s with democratisation and modernisation, which included urbanisation of the island, primary and secondary education up to the age of 15 became compulsory for both boys and girls. During the same period, schools became coeducational. Textbooks, however, were still promoting gender stereotypes and separate boys and girls' activities (GOED, 2006). According to statistical data, in 1960 only 1% of the Greek Cypriots, mainly men, were university graduates. More recent statistical data indicates that approximately 70% of the Greek Cypriots attend tertiary university education with almost an equal number of men and women (The Statistical Portrait of Women in Cyprus, 2008). During the mid-1960s, women had paid jobs outside their homes. However, because of the patriarchal ideology they were still responsible for the domestic chores and caring for their families (Stavrou, 1997).

In the early 1960s, Cypriot women were not involved in political life. During this period, Stella Soulioti a lawyer from an upper middle class family of lawyers was the first Greek-Cypriot woman appointed Minister of Justice by president Makarios and later appointed as Attorney General. Soulioti became part of the existing male-dominated system, and although she was a woman in high position, she did not promote women's issues and bring social change. In 1982, Rina Katselli from the Democratic Party became the first woman MP in the Greek-Cypriot community. Rina Katselli was not a feminist, and promoted by her influential family. Women were still perceived as apolitical, and women's organisations were there only to serve political party agendas. Other organisations for women were of philanthropic nature, helping the poor and sick. In addition, early women's magazines presented women in traditional roles (such as housewives, mothers, and carers of their families), and there was no discussion on gender equality or women's rights. Therefore, gender stereotypes and social prejudices were reproduced by women too (Hadjipavlou, 2010).

Information from the Statistical Portrait of Women in Cyprus (2008) indicates that in 2006 there were only 16.3% of Greek Cypriot women in the government in the Republic of Cyprus (this was increased from 5.1% in 1991). In addition, out of eleven ministers, only two were women. Women judges increased to 38% and senior civil servants increased to 26.8% in 2006 from 2.05% in 1990. Moreover, in 2006 in the municipal councils out of the 414 members only 84 were women.

Statistics also indicate that the wage gap in Cyprus is the highest among European countries with women earning 25% less than men.

Research in recent years indicates that social stereotypes, prejudices, and gender roles have not weakened. However, because more women are educated at universities, they have become conscious of male dominance in the Cypriot society recognising their responsibility to become change agents (GOED, 2006; Hadjipavlou, 2010). Hadjipavlou's research (2004; 2010) has shown that although Cypriot women from all communities (Greek, Turkish, Armenian, Maronite, and Latin Cypriots) have many roles and social positions, find themselves in between traditionalism and modernity as the patriarchal structures remain unchanged with many of them facing the dilemma of either career or family.

3.3 Gender and Educational Choice in Cyprus

The number of female Greek-Cypriot students moving to higher education in Cyprus has been increasing remarkably for over three decades now. This is indicated by data published by the Department of Statistics (2009) which also shows that more female students continue with higher education than males. In addition according to national university entrance examination results published in 2004 in a Cypriot newspaper, *Phileleftheros* (Anon, 2004), out of 16 top achievers in various fields of study 14 were females. However, according to educational sociologists injustices do not lie in exclusion from higher education,

but are found in the imbalanced pattern with which choices are made in terms of gender, social class, and ethnic background (Hodkinson & Sparkes, 1997; Reay, 1998). Both male and female students, whose families are from different sociocultural backgrounds, have different options available resulting in noticeably different social outcomes (Green & Vryonides, 2005).

Cyprus has often been described as a society that struggles to define its current identity, striving between ideological antagonisms and tensions that are produced by modern and traditional elements and perceptions. In such a social setting issues are often raised concerning educational opportunities and equity when examining both individuals' and their families' actions in their efforts to secure the best possible outcomes for their children. Students and families from different social backgrounds make educational choices based on their attitudes and beliefs relating to the way they view the entire range of social relations including gender issues (Green & Vryonides, 2005; Argyrou, 1996). Traditional gender patterns persist in employment, with males dominating high-status professions, and females dominating lower-status and lower-paid sectors (Argyrou, 1996). As indicated by the official statistics published by the Department of Statistics (2008/2009) in Cyprus, with respect to gender there are some noticeable patterns in the higher education population. Male students mainly focus on economics and business studies, IT, medicine, engineering, and technologies; whereas females focus more on education, fine arts, humanities and law, finance, management, business administration, physical sciences, and

mathematics and statistics. These patterns in higher education affect the eventual positions males and females take up in labour market, and therefore justify the picture of social injustice in relation to the position of females in the labour market (Green & Vryonides, 2005).

Green and Vryonides (2005) argue that in a society such as Cyprus, boys and girls have traditionally been socialized to suit gendered expectations resulting to men's and women's different social positions that have continued and reproduced gender inequalities. Over the years, however, because of general structural changes resulting from modernization processes, gendered expectations began to evolve towards more meritocratic trends. Because of these changes, women are now better paid and their positions are better recognized in society. Green and Vryonides maintain that over time Cyprus has changed from being a traditional society to a society that demonstrates many features found in developed western societies in the structure of its economy and in its social and political organization. Within the context of this modernizing society, educational choice-making and other social activities take place. Green and Vryonides argue that Cypriot society's modernization has in no way been a simple development reproducing a simplistic and idealized model of western social, political, and economic transformation. Rather, several characteristics of traditional attitudes and practices are still present among many "modern" Cypriots. Part of the explanation for this is that whereas in the west the transition to modernity had been a cumulative process of two or three centuries, whereby

“old habits, old patterns of authority, old relationships and old values were challenged, disrupted and replaced” (Shipman, 1971, p. 13), in Cyprus the transition to modernity was a product of a recognised, named, and thoroughly pursued effort by Governments (Green & Vryonides, 2005).

Argyrou (1996) also points out that cultural patterns change less rapidly than political and economic phenomena. Therefore, during this fast transition to modernity a rather complex combination of elements of both traditional and modern perspectives in the practices of Cypriot families within and between social classes has emerged. In this social framework, different sections of the Cypriot society approach various social issues in distinctive ways. Argyrou sustains that, in general and as a way of establishing a unique cultural identity, the working classes in Cyprus tend to associate more with traditional ideas, and the middle classes more with modern ones.

In addition, according to Vryonides (2007), the degree to which an individual holds on to traditional or modern ideas affects his/her attitude on issues relating to gender. Within the traditional perspective, women are seen as being mainly mothers, wives, and supporters of the traditional Cypriot family values of housekeeping and raising children. Conversely, modern views support that women should be considered as individuals with the same potentials and rights in the workplace as men. This perspective suggests that women should be regarded as partners in a household, sharing domestic chores equally with their

husbands. Adding to this, women should be given equal opportunities as men in all fields of social life, including similar educational opportunities. In real life, however, things do not work in such dualistic terms. Vryonides (2007) argues that in reality this picture is a lot more complicated as often these two perspectives are interrelated with objective realities compelled by social conditions, such as social class positioning. Nevertheless, the degree to which a family holds on to one viewpoint or the other has an impact on the development and the adoption of different strategies that encourage or restrict children's educational visions.

3.4 The English society and gender roles

During the 20th century, English society has changed significantly compared to previous centuries, especially in terms of the standard of living of ordinary people. Specifically, in 1914 about 20% of the population was middle class and this figure increased to about 30% a few years later, in 1939 (Bédarida, 1991). In the late 20th century, the number of manual workers declined quickly and the number of people working in offices and service industries increased significantly. Another significant change was the large numbers of West Indians and Asians arriving in England in the 1950s. Consequently, in the late 20th century, England became a multi-cultural society. Also in the late 20th century divorce and single parent families became much more common (Strong, 1998). Meanwhile, men and women's roles in English society have changed drastically. In the 1918, women over 30 were allowed to vote and later in 1928 were allowed

to vote at age 21 (the same as men). The 1919 Sex Disqualification Removal Act allowed women to become lawyers, vets, and civil servants (Cornish & Clark, 1989). World War II affected gender roles in England considerably. During World War II, women's traditional roles as housewives and mothers had to change. Apart from taking care of their houses and children, women worked in factories and joined the armed forces. After the war, although women went back to taking care of their children and husbands, the majority of them were contributing along with men in earning money to support their families. This became common for women in the 1950s and 1960s, and towards the end of the 20th century, it was considered normal for married women to have their own careers. In 1970, another significant change in terms of gender emerged; the law had to change so women and men were paid the same wages for doing work of equal value. From 1975 onwards, it is illegal to dismiss women from employment for becoming pregnant. Adding to this, in 1975 the Sex Discrimination Act made it illegal to discriminate against women in employment, education, and training. Consequently, the number of women in managerial and other highly paid jobs increased considerably (Ryder & Silver, 1977; Walby, 1999).

Considering the influential presence of the Queen in British life in the English society, it is obvious that a woman being in a position of power is something well accepted. In 1919, Nancy Astor became the first female MP. In 1929, Margaret Bondfield became the first cabinet minister, and in 1979 Baroness Margaret Thatcher was the first (and the only woman ever) to become British Prime

Minister (Pilcher, 1999). However, the concern of many including educationalists, researchers, and feminists are gender injustices in English education suffered by women. Feminists, in particular, see class in English society as the central element of social structure in which inequality hinges (e.g. Walkerdine, 1998).

3.5 Gender and Educational Choice in England

In England traditionally 'the sciences' have been seen as masculine and the 'arts' as feminine (Walkerdine, 1998). Young men pursue technical and science-oriented subjects, whereas young women pursue caring, or art/humanities/social sciences subjects (Francis, 2002; Smithers & Robinson, 2006). The subjects pursued by young women are constructed as lower-status, and as easy compared to the sciences. Therefore, subjects more often pursued by young men are seen as more difficult and more important in society compared to those pursued by young women (Walkerdine, 1998). Teachers and other educationalists (e.g. career advisors) are often held responsible for reinforcing gender stereotyping and responsible for the subject choices both girls and boys make (Fennema, 1981). These gendered subject choices and subsequent school-to-work routes have powerful consequences for young peoples' future career paths in terms of job opportunities, status and remuneration, and thus for productivity in the economy as a whole (Department of Trade and Industry, 2004; EOC, 2004).

Studies by Colley, Comber, and Hargreaves are good examples of gender differences in school subject preferences among students in England. One study by Colley, Comber, and Hargreaves (1994a) that involved 93 11- and 13- year-old students and examined gender differences in school subject preferences, showed that boys gave significantly higher rankings to physical education and science than girls, while girls gave significantly higher rankings to English than boys. In another study that involved 566 male, and 567 female students aged 11-12-year-old and 15-16-year-old in both single-sex and coeducational secondary schools in England, Colley, Comber, and Hargreaves (1994b) found an effect of gender. Specifically in the rankings of 15-16-year-old students girls were giving higher rankings to art, and boys were giving higher rankings to mathematics, physical education, and science.

Few years later, Colley and Comber (2003) felt that it was worthwhile to revisit the comparison between students aged 11-12-year-old, and 15-16-year-old in both single-sex and coeducational secondary schools in England in order to determine if there was still evidence of greater gender stereotyping of some subjects in the older group, and whether changes in the relative popularity of some subjects have occurred in the two age groups. Their study showed that for 11-12-year-old boys and girls more practical subjects appeared at the top of the rankings, while in all but one school RE (Religious Education) and French appeared towards the bottom. Art and Drama were strongly preferred by girls, while PE (Physical Education), ICT, Art, Technology, and English were preferred

by boys at two schools and Drama, Technology, and Maths were preferred by boys at the third school. In terms of 15-16-year-old boys, practical subjects appeared at the top rankings at two schools and academic subjects at the third selective school. Both maths and science, though, appeared towards the top of the rankings. Music and French appeared at or towards the bottom of all three schools. For 15-16-year-old girls, Art appeared at the top rankings at two schools and English at the top ranking at the third school. Overall, Colley and Comber's study showed that there was a stronger effect of gender for the 15-16-year-olds. Mathematics was gender-neutral for the 11-12-year-olds, but became one of the most masculine subjects for the 15-16-year-olds. PE and ICT were masculine in both age groups, but Drama, English, Geography, and Art were feminine in both age groups. The researchers conclude their study by attributing the gender differences found in school subject preferences to influences from societal gender roles and beliefs associated with them.

While students in England tend to employ stereotypical choices when it comes to studying for A-levels, those boys and girls who elect for non-traditional areas do well (DfES, 2007). Andrews et al. (2006) report that even when girls in England achieve well at school they are more likely than boys are to opt for further and vocational education than higher education. Girls also form the majority of the student population in further education, and they are outperforming boys in terms of qualifications obtained (Leathwood, 2006). However, Skeggs (1997) argues that further and vocational education is seen as the 'poor relation' of education in

terms of financial resources and status. Both further and vocational education is gendered and classed, and it is in these sectors that traditional gendered activity is most evident. For example, Leathwood (2006) shows how the courses and pathways selected by students are highly gendered by observing that female students form 77% of those in adult and community education, compared with 41% in work-based learning. Whilst the majority of social and nursery work courses are comprised of female students, male students choose the more technical programmes (such as construction and engineering) which without doubt lead to more highly paid work. And whilst there is evidence to suggest that young women are more likely to at least consider taking up non-traditional career options, it remains that there are far more females choosing caring jobs and males the more technical and scientific occupations (Francis, 2000).

CHAPTER 4

The structure of the educational system in Cyprus and England

4.1 Outline of Chapter 4

Chapter 4 describes the context in which the students in Cyprus and England are educated; a wider audience might want to know a bit more in order to understand how the selection of the participants was made and why some procedures (described in Chapter 5) were followed in order to make this research project possible. I should note that the information provided in this chapter was accurate at the time of writing; much of this information might change in the future according to plans of the new government in each country.

4.2 The structure of the educational system in Cyprus

The educational system in Cyprus is highly centralized, and controlled by the Ministry of Education (MoEd). The Ministry of Education and Culture is in charge of the curriculum, textbooks, and the other resources that are necessary to deliver it. The appointment of teachers is extremely centralised through the Education Service Commission appointed by the Government. The Ministry of Education and Culture, funds local school boards for matters of building maintenance and supplies. In addition, the Ministry of Education and Culture controls schools directly through the Inspectorate and the school heads. However, school heads have less devolved duties than in many other school systems. The Inspectorate takes direct control of activities in schools, inspects

teachers, and is responsible for teachers support, disciplinary matters, and curriculum development. In addition, the Inspectorate carries out many administrative duties (Ministry of Education and Culture, 2010).

The Ministry of Education and Culture is organised into departments that mirror the structure of the educational system in Cyprus. Specifically, the Primary Department administers the pre-primary and primary education, the Secondary Department administers the secondary education, the Tertiary and Higher Education Department is responsible for tertiary and higher education, and the Technical Education Department is responsible for secondary technical education. In addition, the Ministry of Education and Culture has a Department for Personnel Administration and a Department of Technical Services, which are accountable for planning the building of schools. Each school service is accountable for its own curriculum provision and has its own group of Inspectors. Separate curriculum centres for pre-primary and primary, for secondary, and for technical education carry out curriculum developments. An additional department of the Ministry of Education and Culture is the Pedagogical Institute, which is responsible for the in-service training of teachers and for particular facets of curriculum support (MoEd, 2010).

A series of reforms that took place after the independence of Cyprus from the British in 1960, gradually transformed the education system of the country. These reforms included the formation of a compulsory, nine-year comprehensive

school, which was legislated in 1981, followed by a non-compulsory three-year high school introduced in 1964. The reforms were initiated under the ideals of equality of opportunity, and the formation of citizens of a modern democratic society (Papanastasiou and Zembylas, 2004). The nine-year comprehensive school is divided into two levels, elementary and gymnasium (lower secondary school). Children enter full-time education at elementary school, which is regarded as the key and fundamental stage of education, at the age of approximately five. They then enter full-time education at gymnasium at the age of twelve, which lasts three years. The role of Gymnasium is to develop their interests, and therefore to facilitate the choices they will have to make after they attend high school. In the nine years of comprehensive school, students are taught the same subjects, and use the exact same books. Students may then decide whether they want to continue with the upper level of high school for a further three years of studies. The upper level of high school has two directions, academic (lycea) and vocational (technical schools) (MoEd, 2010). The instruction in Cyprus in the secondary grades has been traditional, teacher-centred, and does not promote student involvement or group work (Papanastasiou, 2002; Trezami, 2009). It is worth mentioning that there are both public and private schools in Cyprus. Public pre-primary, primary, secondary (both lower and upper), and vocational schools are non-profit schools and the language of instruction is Greek. However, some private schools-that range from missionary boarding schools to vocationally- are non-profit and some others are profit making. Their basic languages of instruction are English, French, Italian, or

Arabic. Private schools are run by overseas organisations, or religious authorities and local entrepreneurs (MoEd, 2010).

After the completion of their studies at Gymnasium (lower secondary level), some of the students in Cyprus decide to follow the academic direction of high school and attend Lyceum. Lyceum aims to prepare students for further education and students have access to the same educational resources. In Lyceum, students are offered general education in their first year (Class A'), and more specialised education in their second (Class B') and third (Class C') year. In Class A' students are offered common core subjects, which are obligatory for all students. Common core subjects, which offer general education, multi-faceted development, and acquisition of general skills, include Modern Greek and Mathematics. In Classes B' and C' students attend common core lessons and at the same time choose optional subjects (for systematic and in depth study) which interest them and will help them for their studies at university level. For example, students who might wish to study mathematics or physics at university will take many mathematics, physics, and chemistry classes. Students who wish to get a place at the University of Cyprus or any other university in Greece will have to pass National Exams. These exams are highly competitive. Therefore, students have to take lessons that are required for their exams' preparation. It is in Classes B' and C' that the students who wish to follow a scientific direction at university include advanced mathematics as their optional subject (MoEd, 2010).

Students who decide to follow the vocational direction of high school and attend Technical Education instead, will have to choose between Theoretical and Practical Direction of Technical Education. The main difference between these two directions is that the syllabus of Theoretical Direction emphasizes more science subjects, whereas the syllabus of Practical Direction emphasizes technological subjects, workshop practice, and industrial training. It should be noted that courses of the Theoretical and Practical Directions last for three years. However, during the third year of Practical Direction students have to follow a two-day per week scheme for industrial training. The scheme, which comprises one of the main links between industry and education is organised in close cooperation with the Human Resource Development Authority, and is managed by Instructors/Counsellors who visit students working in Industry on a regular basis in order to make sure that they receive appropriate training according to the requirements and agreed programme of training. Students who choose to attend the Hotel and Catering Branch (waiting and cooking) follow their own industrial training programme. During the second semester of the first year, students are placed in different hotels for two weeks in order to get an initial feeling of the Hotel and Catering Industry. After the students complete their second year of studies, are placed in hotels for twenty weeks as trainee waiters or cooks. There, the students are trained in different sections or areas of their speciality. The scheme functions in collaboration with the Human Resource Development Authority (which contributes financially to the successful operation of the scheme), the Hotel Owners Association, and the Trade Unions (MoEd, 2010).

Many of the students in Cyprus decide after completion of their studies in high school to attend higher education. If they decide to attend higher education at the University of Cyprus (which is a public University offering free education to undergraduate students from Cyprus and Greece) or at any Greek University (which is also free of charge for undergraduate students from Cyprus and Greece) of their choice they will have to pass National Examinations. Otherwise, they might consider attending a private University in Cyprus or abroad. The National Examinations are highly competitive and for that reason, the majority of the students in Cyprus in order to prepare themselves attend afternoon private lessons (tuition). These lessons are offered by private institutions, and students usually attend them after their usual day in high school, and especially during the last two years of high school. The students choose which afternoon classes to attend based on what optional subjects they included in their timetable at school, and what direction they want to follow at university (Papanastasiou & Zembylas, 2006).

Higher education at the University of Cyprus or any other Greek university begins with a four-year Bachelor's Degree. Students might then consider following post-graduate study which might lead to either a Master's Degree (taught degree which lasts two years if taken full-time), or a Doctorate (research degree which lasts at least three years if taken full-time). Higher and Tertiary Education in Cyprus is offered through a wide range of means and methods in public or in private institutions, through full-time, part-time, distance, and other forms of

attendance. Since Cyprus entered the European Union, whose intention is to promote Lifelong Learning, the role of Higher and Tertiary Education has been extended and new needs such as the creation of Open University emerged. With the reforming of the economies of nearly all the countries because of globalization and the fast development of technology, participation in higher education is now an essential qualification for the personal, economic, and social growth of individuals, groups, and countries. Therefore, higher and tertiary education, represent the most significant level of education because it is directly related to employment and contribute considerably to development and social coherence. For that reason the Department of Higher and Tertiary Education (DAAE) of the Ministry of Education and Culture in Cyprus aims to create suitable conditions for the provision of tertiary education and training in academic and professional programmes of studies to as many people as possible (MoEd, 2010).

4.3 The structure of the educational system in England

In England, education is represented by two Ministers in the Cabinet: the Secretary of State for Children, Schools, and Families; and the Secretary of State for Business, Innovation, and Skills. These two Ministers are selected by the Prime Minister and are responsible to the UK Parliament for managing, and directing the public education system in England. The Department for Children, Schools, and Families (DCSF) is responsible for the central administration of all aspects of education and related services in England, excluding further and

higher education that are supervised by the Department of Business, Innovation, and Skills (BIS). The main roles of DCSF include advising ministers on education policy, framing legislation, accounting for the effectiveness of the education system, and allocating, monitoring, and accounting for resources. The Office for Standards in Education, Children's Services, and Skills (Ofsted), which is a non-ministerial department, keeps DCSF informed on the quality of education and care. In addition, there are a number of non-departmental public bodies (NDPBs), which may be established by statute but are not government departments. NDPBs usually operate within broad policy guidelines set by departmental ministers. Their duties may include executive, administrative, regulatory, or commercial functions (Eurydice, 2010).

The Qualifications and Curriculum Development Agency (QCDA), which replaced the Qualifications and Curriculum Authority (QCA), is a new NDPB. QCDA was established by the Apprenticeships, Skills, Children, and Learning Act in 2009 and its responsibilities include developing the pre-school, primary, and secondary curricula, improving and delivering National Curriculum and early years' assessments, and reviewing and reforming qualifications. The Apprenticeships, Skills, Children, and Learning Act in 2009 also established the Office of Qualifications and Examinations Regulator (Ofqual), which is the new independent regulator of qualifications, tests, and examinations. Ofqual's responsibilities include: ensuring that organisations which offer and deliver qualifications have good systems in place and are held to account for their

performances, standards in qualifications, tests and examinations are monitored and the findings are reported; there is fair access to examinations for all candidates; and the quality of marking is high (Eurydice, 2010).

England shares a common system of external qualifications with Wales and Northern Ireland. These qualifications are usually taken between the ages of 16 and 18, and are provided by awarding bodies or awarding organisations (these are independent organisations). The three main awarding organisations in England are the Assessment and Qualifications Alliance (AQA), Edexcel, and the OCR (Oxford, Cambridge, and RSA Examinations). These awarding organisations offer both general and vocational qualifications. They offer the same type of qualifications, which must be centrally approved. However, schools are free to choose examination specifications from any one of the five providers across England, Wales, and Northern Ireland (Eurydice, 2010).

An executive NDPB of the Department for Children, Schools, and Families (DSCF) is the Training and Development Agency for Schools (TDA). The TDA is accountable for initial teacher training and continuing professional development of the whole school workforce, including teachers, support staff, and teaching assistants. Another NDPB of the DCSF is the National College for Leadership of Schools and Children's Services, which offers head teachers, school leaders, and senior leaders of children's services opportunities for professional leadership development. Moreover, Becta is a government-funded agency, operating on

UK-wide basis, which works with the DCSF and other partners to ensure that the potential of technology is taken fully into account in developing future policy. Becta directs the coordination, development, and delivery of the Government's strategy to harness the power of technology to help improve education, skills, and children's services (Eurydice, 2010).

In addition to NDPB, there are several bodies, which besides to their other functions, offer advice to government or represent the interests of certain groups or sectors. One of these bodies is the General Teaching Council for England (GTC), which is an independent professional body for teaching. It is essential for the teachers who wish to teach in maintained schools (schools funded through their local authority) to register with the Council. GTC maintains a record of teachers and a Code of Practice for the profession. Nine Government Offices for the Regions are responsible for managing and delivering some government plans and programmes within the field of education and skills. The Government Offices (GOs) function as a network which intends to connect central government with local people organisations, improve national policy by making sure that this takes account of the various needs of each region, integrate regional strategies, and deliver effectively government programmes regionally and locally (Eurydice, 2010).

At a local level, 150 Local authorities (LAs) are responsible for the management and administration of education. LAs have a legislative obligation to secure the

provision of primary and compulsory secondary education (students aged five to 16). Some other main responsibilities of LAs regarding schools include: school admissions; financial administration; promoting high standards and the fulfilment of potential; staffing and staff development; ensuring regular school attendance; support for inclusion, special educational needs and behaviour support; dealing with complaints; school meals; grants and allowances; and transport to school (DfEE, 2001). Following the introduction of local management of schools (LMS) under the Education Reform Act 1988, most school administration, and management functions are now delegated to school governing bodies.

Governing bodies are accountable for all major decisions about a school and its future. They usually comprise between nine and twenty members. Governors are liable to conduct the school with a view to promoting high standards of educational achievement. The general direction of the school and its curriculum (subject to the requirements of the National Curriculum) is determined by the school governing body. The school governing body must make sure that the National Curriculum is implemented, and that religious education is taught. Moreover, it decides how the budget will be spent, determines the number and composition of the staff, and it is accountable for choosing the head teacher and the other members of the school's leadership group. The head teacher and staff are responsible for reporting to the governing body on the school's overall performance. In its turn, the governing body should ensure accountability to parents and the wider local community (Eurydice, 2010).

Every school has a head teacher who is responsible for the internal organisation, management, and control of the school. A school's staffing structure typically includes the Senior Leadership Team (SLT). In addition to the head teacher, the SLT would include one or more deputy head teachers and one or more assistant head teachers. A small primary school might have only one deputy head teacher who would have both management and teaching duties. On the other hand, a large secondary school might have up to six deputies with assistant heads who would spend only a small amount of their time in the classroom. In some cases, the SLT may include staff who is not teachers, such as a bursar or a school business manager. The staffing structure usually also includes a middle leadership layer. Middle managers might include heads of department or curriculum areas (in a secondary school), accountable for managing subject teaching in their areas, as well as heads of year or key stage managers, accountable for students' pastoral care. Parents are responsible for ensuring that their children of compulsory school age receive an efficient full-time education suitable to their age, ability, and aptitude, and to any other special educational needs (SEN) they may have (Eurydice, 2010).

The Department for Business, Innovation, and Skills (BIS) is the government department responsible for further education policy. BIS is also accountable for science and innovation, higher education and enterprise. From 2010 onwards, LAs are responsible for the commissioning and funding of provision for all children in the 0 to 19- age range. The Young People's Learning Agency (YPLA),

which is a new organisation, supports LAs in carrying out their new duties. Moreover, Skills Funding Agency (SFA) is responsible for post-19 education. SFA is supported by Adult Advancement and Careers Service (AACCS) and a National Employer Service, which offer skills advice and support large national employers. The National Apprenticeship Service within the SFA provides leadership, support, and advocacy for Apprenticeship programmes. The Learning and Skills Improvement Service (LSIS), a new sector-owned organisation, supports excellence, leadership development, and self-regulation in the further education sector. Further Education (FE) colleges are public corporations, and are therefore subject to company law. Each of them has a governing body or corporation, often comprising between ten and twenty members. These members are responsible for all decisions affecting the institution. The principal and management team of each college are accountable for a day-to-day management, organisation, and direction of their college. In addition, the principal is directly responsible to the governing body/corporation for the performance of the institution, in terms of both academic and financial matters (Eurydice, 2010).

The educational system in England is structured in six different levels, which are pre-school education, preparatory education, primary education, secondary education, post-16 education, and post-18 education. It is required for all children in England aged between five and sixteen (inclusive) to attend full-time education (Education Act, 1996). It should be noted, however, that although education is

compulsory from the age of five to sixteen, school is not. Under the Education Act 1996, parents are responsible for a child's education. It is parents' decision whether their children are educated at home instead of school. This form of education is known as Elective Home Education. Local Authorities still have responsibilities towards the children who are educated at home, and in year 2007 the former Government produced guidance to support them in carrying out their legislative responsibilities (DCSF, 2007).

The Education Act 1996, divided the period of compulsory education into four key stages. Primary education covers key stages 1 and 2. Key stage 1 caters for pupils aged five to seven years and key stage 2 for those aged seven to eleven years. For children who reach compulsory school age before the start of key stage 1 schools provide a reception class. Reception places may also be available for four-year olds for all or part of the year. In some areas of England, there are separate 'infant' schools for pupils in key stage 1 (aged five to seven), and 'junior' schools for pupils in key stage 2 (aged seven to eleven). In a few areas of England schools are organised in three phases: primary or 'first' schools (for pupils aged five to eight or nine years), middle schools (for pupils aged eight to twelve years or nine to thirteen years), and secondary or high schools (for students aged twelve or thirteen to sixteen+ years).

Under the School Standards and Framework Act 1998, maintained primary and secondary schools are divided into community, voluntary, and foundation

schools. Most of the schools are community schools, which are established and fully funded by local authorities (LAs). LAs also fund foundation schools. These schools, however, are owned by the school governing body or a charitable foundation. Voluntary schools were originally established by voluntary bodies, mainly churches, which retain some control over their management. They are now largely funded by LAs. In England, there are also independent schools, known as private schools. Independent schools, receive no funding, and are mainly financed by fees paid by parents.

Most children in primary level are taught in mixed-ability classes with children of the same age. Some schools teach some subjects, such as maths, in groups organised based on ability. Smaller or rural schools may have mixed-aged classes. Compulsory subjects at primary level include the core subjects (English, mathematics, and science), and the foundation subjects (design and technology, information and communication technology (ICT), history, geography, art and design, music and physical education (PE)). Religious education (RE) is also a statutory subject throughout compulsory education, although parents have the right to withdraw their children from this subject if they wish. All local authorities (LAs) are required to adopt a locally agreed syllabus for RE, which must 'reflect the fact that the religious traditions in Great Britain are in the main Christian, whilst taking account of the teaching and practices of the other principal religions represented in Great Britain'. Teaching methods and learning materials are usually decided by the class teacher, in consultation with the head teacher and

subject leader (or subject coordinators), who are classroom teachers with additional responsibility for a particular subject area and who give help and guidance to their colleagues within the school. Commercial publishers produce textbooks, and do not require government approval. All schools have computers available for use by pupils (Eurydice, 2010).

Pupils in England transfer from primary to secondary schools at the age of eleven. Most of maintained secondary schools are non-selective (they do not select students based on ability). In some areas of England, however, grammar schools are the only maintained schools permitted to operate a fully selective admissions policy. In addition, outside the maintained sector there are academies. Academies are all-ability schools established by sponsors from business, faith, or voluntary groups working in innovative partnerships with central government and local education partners. Moreover, there are private schools that are independent schools and are largely financed by fees paid by parents. It is worth mentioning that 90% of publicly funded secondary schools are mixed-sex and only 10% are single-sex (Eurydice, 2010).

Some secondary schools in England only cater for students aged eleven to sixteen. There are, however, many secondary schools, which have a sixth form providing full-time post-compulsory education to students aged sixteen to nineteen. Compulsory secondary education covers key stages 3 and 4. Key stage 3 caters for students aged eleven to fourteen, and key stage 4 caters for

students aged fourteen to sixteen. At key stages 3 and 4, secondary schools offer general/academic education as set out in the National Curriculum. At key stage 4 and post-16, secondary schools provide external qualifications in general subjects along with some courses in vocational/applied subjects. At key stage 3 the compulsory National Curriculum subjects include: the core subjects (English, mathematics, and science); and the foundation subjects (design and technology, information and communication technology (ICT), history, geography, art and design, a foreign language, citizenship, music and physical education (PE)). At key stage 4, there are less compulsory National Curriculum subjects: English, mathematics, science, ICT, PE, and citizenship. Additionally, there are statutory 'curriculum entitlement areas', which are the arts, design and technology, the humanities, and modern foreign languages. As at primary level, religious education (RE) is compulsory at key stages 3 and 4. However, parents who wish to withdraw their children from RE lessons have the right to do so. At the end of key stage 4, most of the students are assessed by means of external qualifications. These qualifications are developed by awarding bodies or awarding organisations, which are regulated by the Office of the Qualifications and Examinations Regulator (Ofqual). The most common qualification taken is the GCSE, a single subject qualification available in more than forty academic subject areas (Eurydice, 2010).

At the age of sixteen, students decide whether to carry on or not with their education. In England, there are further education (FE) institutions, which provide

full- and part-time post-compulsory education to students aged sixteen to nineteen. The majority of further education institutions offer both vocational and general academic courses. Further education institutions include general FE colleges, specialist colleges, and sixth-form colleges. General FE colleges place a greater emphasis on vocational courses, but also offer general courses. Specialist colleges provide courses in a specific area of the curriculum such as art, or in a vocational area such as agriculture. Sixth form colleges offer full-time general secondary education courses and also some vocational courses (courses are generally the same as those offered in school sixth-forms, but sixth-form colleges often offer a wider choice of both general and vocational programmes) (Eurydice, 2010).

As well as state-funded FE colleges, there are a considerable number of private and third sector providers in the FE sector. Individual schools, colleges, or employers, set their own entry requirements to post-compulsory education, and training programmes. Students who wish to continue in the sixth form of their secondary school must still apply for admission to specific programmes. Schools normally ask for a minimum of five General Certificate of Secondary Education (GCSE) passes at grades A* - C for admission to A-level courses. In addition, criteria for admission to A-level courses usually include the achievement of GCSE passes at specified grades in the subjects to be studied at A-level. The National Curriculum does not apply to students attending post-compulsory education. Students choose courses of study from the range offered by the

school or Further Education College, depending on the qualifications they wish to gain. Education in England is provided free of charge for students up to the age of nineteen (Eurydice, 2010).

The most common qualifications taken at the end of post-compulsory education are A-levels. These are single subject examinations, which may be studied in any combination, within the limit of the school's or Further Education College's timetable and the range of subjects it offers. During the first year of post-compulsory education, students usually take four or five subjects leading to AS-level qualifications. These are standalone qualifications, and typically consist of three units. In the second year of post-compulsory education, students usually follow three of their four or five AS-qualifications subjects to A2. A2 is the second half of the full A-level qualification, consisting of a further three units. GCEs or A-levels in applied subjects are also available to students in post-compulsory education. These qualifications are intended to offer a comprehensive preparation for employment, as well as a route to higher-level qualifications. Students usually require two or three A-level qualifications in order to enter higher education (HE). There are also other existing qualifications. For example, Diplomas are new qualifications, which combine theoretical study with practical experience, and are part of the Government's 14 to 19 reform programme. National Vocational Qualifications (NVQs) also enable students as well as employees who have left full-time education to gain recognised qualifications for specific occupations. Business and Technology Education Council (BTEC)

qualifications are designed for study in occupational areas, and involve a mixture of theoretical and practical work. In addition, introductory certificates and diplomas are vocational qualifications available in applied subjects. These qualifications offer young people and adults the opportunity to take full-time or part-time programmes of study, which will allow them to enter employment or further/higher education (Eurydice, 2010).

After the age of eighteen, students might wish to continue their studies in higher education institutions (HEIs). Higher education institutions in England are independent, self-governing bodies active in teaching, research, and scholarship. Prior 2005, the only institutions that were permitted to use the title 'university' were those with the authority to award both taught and research degrees. However, after 2005 institutions in England and Wales, that award only taught degrees and which meet certain numerical criteria may be permitted to use the same title. Other institutions are often called 'university colleges'. These are institutions that award only taught degrees, but which do not meet certain numerical criteria. In addition, there are some higher education institutions, which are often referred to as higher education colleges. In England, in 2008, there were 90 universities and 133 higher education institutions in total. HEIs determine their own admissions policies and the entry requirements for each programme of studies, which are set out in the institution's prospectus. Prospective students applying for a specific programme are required to have two or three GCE A-levels or equivalent qualifications. Undergraduate studies that

usually last three years (if taken full-time) lead to Bachelor's degrees with honours. Postgraduate studies lead either to the award of a Master's degree which is a taught degree and takes at least one year (if taken full-time), or the award of a Doctorate which is a research degree that may include both research and taught elements. Doctoral programmes take at least three years (Universities UK).

CHAPTER 5

Methodological Considerations

5.1 Outline of Chapter 5

This chapter involves a discussion of the three research paradigms with a justification for the paradigm adopted for this study. An overview of research methods used in studies concerning attitudes follows, and then the research methods adopted for this study are presented. I then discuss how trustworthiness was met in this study, and how I conducted ethical research.

5.2 Research paradigms

Before planning my study, I took into consideration the three research paradigms and examined them with reference into gender and mathematics education and my research problem. The first research paradigm is the positivist or scientific paradigm, which concerns the concepts of “behaviour” and “action” (Cohen, Manion, and Morrison 2007). This paradigm aims to produce objective replicable knowledge (this can be achieved only when the data and methods used are robust enough), usually by using statistical methods which are quantitative in nature such as structured questionnaires looking for general laws, which can foretell educational outcomes, and looking at classroom and learner variables (Cohen et al. 2007; Ernest, 1994). The positivist paradigm, which has its origins in the physical sciences, is frequently related to the cognitive theory of learning.

However, it fails to take account of individuals' unique ability to interpret their experiences and represent them to themselves (Cohen et al. 2007).

When the positivist paradigm is used in researching gender in mathematics education, it focuses on: differences in achievement, and participation between males and females (e.g. Fennema, 1974; Fennema & Sherman, 1977, 1978; Hargreaves, Homer, Swinnerton, 2008); attitudes towards mathematics (e.g. Karimi & Venkatesan, 2009); gender-related differences in spatial visualization and its correlation with achievement in mathematics (e.g. Fennema & Tartre, 1985; Kaur, 1990); and differential teacher-student interaction patterns (e.g. Eccles & Blumenfeld, 1985; Koehler, 1990; Leder, 1992).

Even though many researchers choose to work within the scientific paradigm using positivism, in terms of its ontological and epistemological foundations this paradigm has been criticised significantly by others. Those opposed to positivism were some well-known intellectuals from around Europe, such as philosophers, social scientists, social critics, and creative artists. For example, Kierkegaard (1974) believes that scientific research contributes to the dehumanization of the individual and he is concerned of its objectivity, stressing the need to regain subjectivity. On the other hand, Ion (1977) is more worried about the way quantification and computation, are used. He regards quantification as a type of collectivism and argues that it can cause depersonalisation. Hampden-Turner (1970) also argues that scientific

research is biased, because it is limited and produces an equally limited view of individuals. He claims that the outcomes of scientific research are very focussed on tedious, predictable, and invariant features of their work to the exclusion of subjectivity.

The interpretive paradigm concerns the different conceptions of theory (Cohen et al., 2007). This paradigm is characterized by a concern for the individual and it focuses in understanding the subjective world of human behaviour using qualitative forms of enquiry such as case studies or interviews, trying to negate its subjectivity occurring from weaknesses by triangulating numerous standpoints (Cohen et al, 2007; Ernest, 1994). The theory of learning fundamental to this paradigm is usually a constructivist one, where the mind actively attempts to make sense of the knowledge gained (Ernest, 1994). Researchers working within this paradigm start with individuals and aim to understand their interpretations of the world around them. They work directly with experience and understanding to build their theory on them (Cohen et al. 2007).

Research within this paradigm, however, has been criticised and some of its weaknesses were pointed out by critics. For example, what is in question is whether carefully controlled interviews such as those used in social surveys are unclear then the less controlled interviews carry even greater risks of ambiguity (Argyle, 1978). Another weakness is the way one interprets and defines a situation, which can itself be a product of the circumstances in which one is

placed (Berstein, 1974). Therefore, it is important for the researcher who adopts this paradigm if conducting interviews to control their reliability and to avoid imposing his/her own definitions of a situation upon participants. Layder (1994) also points out that there is always a risk with those who use interpretive approaches to neglect the power of external-structural-forces that shape behaviour and events. Interpretive approaches may put false boundaries around participants' behaviour.

Despite the criticisms concerning the interpretive paradigm, qualitative researchers' primary aim is to add knowledge and not to pass judgement on a setting. They tend to believe that situations are complex. Therefore, they attempt to describe many dimensions rather than to narrow the field. They can control their own biases by recording detailed field notes that include reflections of their own subjectivity; or by working in teams, and have their field notes critiqued by a colleague as an additional check on bias (Cohen et al. 2007).

In gender and mathematics education, the interpretive paradigm focuses on gender-related processes involved in mathematical thinking. The main areas of focus include: women's ways of knowing in mathematics (e.g. Becker, 1996; Erchick, 1996; Johnston, 1998); social, cultural, and classroom factors that reinforce gender differences in mathematical achievement (e.g. Burton, 1990; Isaacson, 1989, 1990; Leder, 1990); and the role of media and popular culture in

reinforcing essentialist perspectives on women to do mathematics (e.g. Damarin, 1996; Zevenbergen, 1998).

The third paradigm is the critical paradigm. The critical paradigm is similar to the interpretive paradigm; however is not merely concerned with the knowledge gained but at the same time is concerned with the positive social implications (Cohen et al., 2007). The aim of this paradigm is not only to understand situations and phenomena, but also to change them. Particularly it looks for emancipating the disempowered, redressing inequality, and promoting individual freedoms within a democratic society (Cohen et al. 2007; Morrison, 1995). Gender research itself has been concerned with rectifying gender inequalities and within this paradigm has changed from descriptions based on static categories to more socially dynamic and changing categories, in which the dynamic is caused by a demonstration of power relationships, which are realised through the construction of differences. Therefore, gender in this case is a hierarchical relation created and recreated by social practices (Cornell, 1987). The weakness of this paradigm is that because of hidden institutional sources opposed to change, there is often little or no progress achieved from the amount of time invested (Ernest, 1994).

Critical approaches like positivist and interpretive approaches have also received several criticisms. Morrison (1995) argues that whether a person or society can become emancipated just by the exercise of ideology critique or

action research is an empirical rather than logical matter. In fact, emancipated societies do not essentially exhibit or necessitate an awareness of ideology critique; they can become emancipated by other means. In addition, Roderick (1986) interrogates whether the adoption of ideology critique is itself as ideological as the approaches it condemns. Moreover, Morrison (1995) points out that critical theory has an intentional political agenda, and that a researcher's duty is not to be an ideologue or to have an agenda, but to be detached, unbiased, and objective. Certainly, critical researchers would argue that the need for researchers to be disinterested and impartial is just as value laden as the need for them to intrude their own perspectives.

In gender and mathematics education, researchers who work with the critical paradigm tend to see gender as intertwined with issues of race, ethnicity, culture, and class. Their main areas of focus include: the possibility of a feminist mathematics (e.g. Damarin, 1990, 1994, 1995; Isaacson, 1986; Jacobs, 1994); the necessity of female voices to be heard in the domain of mathematics (e.g. Buerk, 1996; Campbell & Greenberg, 1993; Gray, 1996); socioeconomic status in relation to achievement (e.g. Bosch & Tregalos, 1996; Forbes & Mako, 1993); participation vs. performance viewpoint (e.g. Burton, 1990; Grevholm, 1996); and development of curriculum sensitive to learning needs of women (e.g. Barnes, 1996; Willis, 1998).

Critical research is closely connected with feminist research. For over three decades, feminist empiricism has had a great influence upon research into gender inequalities. Harding (1986, 1987) indicates that feminist empiricism begins with the idea that some of the practices, procedures, and assumptions of mathematics, science, and their global methods are biased against women. The fundamental ideas of feminist empiricism have contributed to the problematizing of certain practices within every field of mathematics; this has led to thorough analyses of ways in which sexism influences research (e.g. Eichler, 1988). These studies show that sexism can affect studies in mathematics education at all levels: to the composition of research problems; in the methods of collecting information; in coding and analysing data; and in interpreting the results. Squire (1989) points out that constructs that were previously associated with masculinity such as aggression are usually studied with prominent experimental methods. On the other hand, constructs related with femininity, such as anxiety, are examined through the softer methods of questionnaires. Harding (1987) indicates that feminist empiricists try hard to eradicate all such biases and allow the development of new ideas, which can offer alternative explanations of the world.

A great amount of research to the study of gender and mathematics belongs to the tradition of feminist empiricism. Fox, Fennema, and Sherman (1977) are some of the early researchers who addressed problems in the scientific literature of that time and outlined research issues and agenda for less sexist

studies to follow. They designed and framed questions that avoided problems identified by Eichler (1988) and Squire (1989) and introduced many new constructs that helped gender research to move forward, including mathematics as a male domain (Fennema and Sherman, 1977) and mathematics anxiety (Tobias, 1978). Later Fennema and Peterson (1985) introduced 'autonomous learning and behaviours' and Turkle (1984) linked this with "hard" and "soft" forms of mastery. In addition, Fennema (1980) refined and explained in detail the concept of equity. Other research was conducted on affective variables concerned with mathematical learning. For example, Reyes and Stanic (1988), in order to explain group differences in mathematical performance, developed a model which was concerned not only with gender and race but also with socioeconomic status, and used variables such as societal influences, school mathematics curricula, teacher attitudes, student attitudes, achievement related behaviour, classroom processes, and student achievement. Damarin (1995) points out that empirical research on gender and mathematics has reframed the scientific study of women and mathematics. She suggests that this work must continue in order to produce new scientific knowledge.

Having carefully considered the benefits and weaknesses of each of the three research paradigms, I approach my study through an interpretivist lens as a researcher, however, using both quantitative and qualitative methods of data collection, and analysis. Interpretive research is a tool that is sensitive to the

individual and gives the researcher the opportunity to try to get inside the person and understand from within. Therefore, the role of the scientist in the interpretive paradigm is to “understand, explain, and demystify social reality through the eyes of different participants” (Cohen et al. 2007, p. 19). By giving students the opportunity to open up and share their thoughts and feelings about mathematics with me, I will be able to understand why certain attitudes towards mathematics are formed and find out possible reasons for differences in attitudes towards mathematics between male and female students within countries and across countries.

The ontological assumption of an interpretivist is that reality is relative, local, and particularly constructed, and that every construct is of equal significance (Guba & Lincoln, 1994; LeCompte & Schensul, 1999). The epistemological assumption of interpretive research is that the researcher and the researched are interactively related and knowledge assumptions are subjective (Guba & Lincoln, 1994). Research within the interpretive paradigm is value-laden. Interpretivists define “shared constructs and meanings as “situated”; that is, they are located in or affected by the social, political, cultural, economic, ethnic, age, gender, and other contextual characteristics of those who espouse them” (LeCompte & Schensul, 1999, p. 49). Under this argument, it is not feasible to eliminate bias. Instead, values have “pride and place” (Guba & Lincoln, 1994, p. 114) and measures should be taken to explicitly explain the role of bias in the interpretation of findings (Cohen et al. 2007).

These ontological and epistemological assumptions lead to methodological assumptions. It is important at this stage before going into more details to note the difference between method and methodology. Ernest (1998b) explains:

“Educational-research methods are specific and concrete approaches. In contrast, education-research methodology is a theory of methods – the underlying theoretical framework and the set of epistemological (and ontological) assumptions that determine a way of viewing the world and, hence, that underpin the choice of research methods.” (p. 35)

In other words, Ernest (1998b) implies that while the general tendency is to use quantitative methods within a positivist paradigm and qualitative methods within an interpretive paradigm, the methodology of a paradigm is not essentially restricted to particular methods. Although methodology may influence methods, methods should be selected so that they address the research questions. The methodological assumption of an interpretivist is that “authentic or valid individual constructs or ideas can be elicited and refined only through interaction between and among all researchers, participants, and partners in the project” (LeCompte & Schensul, 1999, p. 50).

5.3 Review of methods used in related studies of attitudes

As I discussed in Chapter 2, the definition of attitudes adopted for this study includes both cognitive domains (such as beliefs) and affective domains (such

as attitudes and feelings). Therefore, in search for the best methods and techniques for my study, I have reviewed all the methods I have found to be used in related studies of attitudes and beliefs. Extensive reviews of the literature on attitudes studies (e.g. Leder, 1995; McLeod, 1992; Ma & Kishor, 1997), show that most research in this area generally “follow the traditional paradigm of quantitative research” (McLeod, 1992, p. 588) such as the use of various types of questionnaires, or some standardised attitudinal scales (e.g. Brown et al. 2008; Georgiou et al. 2007; Karimi & Venkatesan, 2009). One of the most popular attitudinal scales has been the Fennema-Sherman Mathematics Attitude Scales developed by Fennema and Sherman (1976) to measure attitudes towards mathematics learning especially regarding gender differences. On the other hand, recent research on beliefs has tended to use both qualitative methods such as interviews and quantitative methods (e.g. Kleanthous & Williams, 2009; Nicolaou & Philippou, 2007; Yu, 2008). In fact, in recent years, more researchers have supported the use of research techniques, including both quantitative and qualitative methods, for the best attainment of their research aims (e.g. Mendick et al. 2008; Reiss et al. 2011). McLeod (1992) proposes that “research on affective issues in mathematics education should develop a wide variety of methods” (p. 591). Other researchers (e.g. Brookhart & Freeman, 1992) recommended qualitative research methods as promising and appropriate for the study of beliefs.

It seems that both methods are promising in these types of research. When deciding which method to use in our research projects, the best method should be the one that help us to examine what we need effectively. The choice of methods also depends on the nature of the research design, that is the sample size and the research aims. For small sample size and in-depth studies, qualitative studies are more appropriate. For a large sample size and exploratory studies aiming for generalisation, quantitative methods using questionnaire might be more suitable and more practical in terms of the cost and time involved (Cohen et al. 2007).

Since the aim of the study is to examine gender differences in attitudes towards mathematics and compare them within and across Cyprus and England in order to find out possible influences and causes of these differences, I chose to integrate quantitative and qualitative methods. The idea is that quantitative and qualitative methods of data collection will be used concurrently, whereas quantitative and qualitative data will be analysed separately. Together findings from the data analyses of the two methods will be juxtaposed and generate complementary insights that together create a bigger picture.

5.4 Methods of the study

5.4.1 Participants

The participants who voluntarily took part in this study were sixth form high-achieving students from one lyceum (upper secondary school) in Cyprus, and sixth form high-achieving students from one college in England opting for advanced level mathematics. To be more precise, 11 (6 male and 5 female students) sixth form lyceum students in Cyprus who were taking advanced mathematics, and 16 sixth form college students in England of whom 8 (5 male and 3 female students) were taking advanced mathematics and 8 (4 male and 4 female students) were taking further advanced mathematics volunteered to be interviewed. In addition, all the sixth form students in Cyprus (62 students in total) taking advanced mathematics at the lyceum under study and all the students in England from the participating college (406 students who finished their AS-level mathematics exams and were planning to take A-level mathematics) completed a questionnaire. The participants from both countries ranged in age from 17 to 18 years. The pseudonyms of the male and female participants from each country are listed in Appendix 5A in Tables 5.1 and 5.2. Participants were selected using a purposive sample since the objective of the study was to discover, understand, and gain insight, into students' attitudes towards mathematics. It should be noted that the students in Cyprus involved in the study were students who finished their second year of lyceum and moved to their third and final year of studies. During their second year of lyceum, students took mathematics (equivalent to AS level), which included pure mathematics, statistics, and mechanics. In their final year of lyceum students study both pure and applied modules (the syllabus

includes areas such as calculus, complex numbers, matrices, Taylor series, etc). In England the students involved in the study finished their AS examinations and moved to their second year of college to do more mathematics units. During the second year, students have the choice to either do further pure mathematics (unit FP1), statistics (unit S2), and mechanics (unit M2) to obtain an AS-level further mathematics or do these three units in January and also in June do units further pure 2 and 3 (FP2 and FP3), and mechanics 3 (M3) to obtain an A-level in further mathematics making two A-level in mathematics in total over the two years.

5.4.2 The participating Lyceum and College

The participants from Cyprus were enrolled in a public coeducational lyceum (upper secondary school) located in a middle class neighbourhood (i.e. a neighbourhood whose families typically have high level of education, high income, etc.) in Nicosia, the capital of Cyprus. At the time of study, the lyceum was eight years old and the student body consisted of approximately 1030 students ages 15 to 18. The students of this lyceum were all Greek-Cypriot students. The participants from England were enrolled in a sixth form coeducational college in the East Midlands. When the study took place, the college was thirty-four years old and consisted of approximately of 1900 16 to 18 year-old students. The majority (approximately 70%) of the students enrolled in the college were from minority ethnic backgrounds, primarily Asian, and of a middle class socioeconomic status (this classification is based on the

location of the college where families typically have high level of education and high income). I should note that the lyceum and the college involved in the study were not any different to other lyceums in Nicosia or colleges in East midlands from neighbourhoods of similar socioeconomic statuses. The reason for involving students from these particular lyceum and college was that access was offered from their head teachers.

5.4.3 Study's instruments

Before designing the instruments used for collecting data for this study, I needed first to find a clear theoretical framework about attitudes towards mathematics. In mathematics education research, studies about attitudes towards mathematics do not provide a clear definition of the attitude construct. Therefore, the attitude construct is often functional to the researcher's self-posed problems (Daskalogianni & Simpson, 2000). I first framed the questions of my study and then framed an appropriate definition for attitudes towards mathematics based on the objectives of my study, and on what I wanted to find out from the participants. Having now carefully thought of my research questions and defined attitudes, I then decided on the instruments that would help me collect the information I needed from the participants.

5.4.3.1 The Questionnaire

Hendley et al. (1995) indicate that in order to investigate students' attitudes, Likert-type attitude scales are appropriate to designing-studies. These rating

scales provide a range of responses (for example responses from strongly disagree to strongly agree) to a given question or statement of a questionnaire. Likert-type scales enable quantitative comparisons to be made between different groups (e.g. girls versus boys, students of different ages etc.), and permit factor analysis (e.g. Parkinson et al. 1998). A Likert scale is also the most popular scaling method used by psychologists when studying opinions and attitudes. As I mentioned earlier, the most popular instrument in research about attitudes towards mathematics is the Fennema-Sherman Mathematics Attitude Scale (1976). The Fennema-Sherman Mathematics Attitude Scales consists of 108 items measuring attitudes that are divided in nine different scales: attitudes towards success in mathematics scale; mathematics as a male domain scale; mother's mathematics attitude scale; father's mathematics attitude scale; teacher's mathematics attitude scale; mathematics anxiety scale; mathematics usefulness scale; motivation in mathematics scale; and confidence in mathematics scale. These attitude scales take approximately forty-five minutes to be answered. A recent popular instrument measuring attitudes towards mathematics is The Attitudes Towards Mathematics Inventory (ATMI) by Tapia and Marsh (2004). ATMI consists of 40 items that measure attitudes and are divided in four scales: enjoyment; general motivation; self-confidence; and value.

The Fennema-Sherman instrument is over thirty years old, takes quite a long time to answer, and subsequent research has questioned the validity, reliability,

and integrity of its scores. Therefore, for the purpose of the study I designed an appropriate questionnaire measuring attitudes towards mathematics with only 32 items (statements) which was inspired by both the Fennema-Sherman instrument and The Attitudes Towards Mathematics Inventory (ATMI) (Appendix 5B). Specifically, certain items from the Fennema-Sherman Attitude Scales were selected and modified. For example, Fennema and Sherman use the statement “Women can do as well as men in math” to examine mathematics as a male domain. I used “Female students are as good as male students when solving a maths problem”. Tapia and Marsh (2004) also use the enjoyment scale, which Fennema and Sherman (1976) did not use in their instrument. Therefore, in order to measure enjoyment of mathematics I used two statements from ATMI. One statement was “Mathematics is dull and boring” and the other one was “I really like mathematics” which I modified to “I like mathematics”. In order to check the reliability of my questionnaire I calculated Cronbach’s alpha (see section on reliability). I should also note that some of the items of the questionnaire were reversed-phrased in order to reduce response bias.

Students were given a range of five responses (from strongly disagree to strongly agree-these rating scales are known as Likert scales named after their deviser Rensis Likert 1932) in order to respond to each item. The items of the questionnaire assessed: students’ perceptions of the relevance of mathematics in their life now and in the future; students’ enjoyment of mathematics; students’ feelings of anxiety; students’ attributions of success or failure in mathematics;

students' confidence in their mathematical abilities; students' motivation; students' perceptions of their parents' expectations with regards to mathematics; students' perceptions of their mathematics teacher's expectations; and students' perceptions of mathematics as a male domain.

Before administering the questionnaire, it was first piloted in order to check the clarity of its items, to gain feedback on the validity of the items, to eliminate ambiguities or difficulties in wording. The questionnaire was piloted by administering it to a small sample of students in Cyprus and England in order to check that the instructions were explicit and to remove any questions that did not yield any useful data. In addition, it was important for the questionnaire to be translated into both English and Greek language since the students involved were from both countries. Therefore, the questionnaire was translated first by me and then by another translator who his native language is Greek and who is a fluent English speaker in order to check whether the questions in each questionnaire had the same meaning and understanding. It should be also noted that it was essential to send the Greek version of the questionnaire to the Head of Directorate of Secondary teachers (ministry of Education) in Cyprus in order to have a look at it (since part of the study was taking place in Cyprus) and then she would forward it to a panel of the ministry of Education in order to check it as well and give their permission for conducting the study. It was also important for the head of the participating college in England, and

the head of mathematics to check the English version of the questionnaire before giving their permission for administering it.

5.4.3.2 The interview

According to Kvale (1996, p. 11) when interviewing participants are not just seen as “manipulable”, and data is not somehow external to them. Kvale (1996, p.14) points out that an interview is an interchange of views between two or more people on a subject of common interest, and sees the centrality of individual interaction for knowledge production and highlights the social “situatedness” of research data. Cohen et al. (2007) maintain that interviews allow participants to be the interviewers or the interviewees, talk about their understanding of the world they live in, and express how they view situations from their own viewpoint. Therefore, the interview is not just concerned with collecting data about life but it is rather part of life itself.

The study involved a semi-structured interview (Appendix 5C) with 11 high-achieving sixth form students from Cyprus taking advanced mathematics and 16 high-achieving sixth form students from England, 8 of whom were taking advanced mathematics and 8 taking further advanced mathematics. Because I wanted to involve only high achieving students from both countries, I asked the mathematics teachers in each country to select volunteers based on their achievement scores. The reason for choosing a semi-structured interview rather than a structured one was that it would allow me to do some modification, if

needed, to the wording and sequence of questions. By not creating a “close situation”, I allowed the interviewees to feel more comfortable and express themselves easier (Cohen et al. 2007).

The interview, which consisted of 15 questions, was translated from English into Greek language. It was essential to make sure that the participants from both countries were asked exactly the same things, therefore a translator (who spoke both Greek and English fluently) was asked to confirm whether the translation was accurate. Similar to the questionnaire items, the interview questions assessed: students’ perceptions of the relevance of mathematics in their life now and in the future; students’ enjoyment of mathematics; students’ feelings of anxiety; students’ attributions of success or failure in mathematics; students’ confidence in their mathematical abilities; students’ motivation; students’ perceptions of their parents’ expectations with regards to mathematics; students’ perceptions of their parents’ motivation with regards to mathematics; students’ perceptions of their mathematics teacher’s expectations; students’ perceptions of their mathematics teacher’s motivation; and students’ perceptions of mathematics as a male domain. The purpose of the interview was to give a better understanding and more strength to the findings from the questionnaire data.

Before interviewing the participants of the study, I first interviewed a small sample of students in both Cyprus and England in order to see whether they could understand the questions clearly. I should note that it was necessary to

send the Greek version of the interview questions to the head of the directorate of secondary teachers in Cyprus in order to have a look at it and give her permission to conduct the study there. It was also important to send the English version of the interview questions to the head and the head of mathematics of the English college so that they could then decide whether to allow me or not to conduct the study in their college.

5.5 Meeting trustworthiness criteria

The aim of trustworthiness in research is to support the argument that the research's findings are worthy of attention. In quantitative research, trustworthiness of research is determined according to constructs known as internal and external validity and reliability. The researcher takes an objectivist stance (Cohen et al. 2007). In qualitative research, there are four criteria of trustworthiness. Internal validity in qualitative research is analogous to "credibility"; external validity is analogous to "transferability", reliability to "dependability", and objectivity to "confirmability" (Lincoln & Guba, 1985).

Validity is very important to effective research, and is essential for every research study in order to provide credible conclusions (Bernard, 2000; Cohen et al. 2007; Sapsford & Jupp, 1996). In quantitative research in order to measure validity someone has to ask himself/herself the question whether he/she measures what he/she wants to measure (Mujis, 2004). Students' attitude towards mathematics is an abstract concept: it cannot be directly measured. It is in that sense a *latent*

variable. In the present study, it was important to design an instrument that would measure students' attitudes indirectly, such as a questionnaire. Every item of the questionnaire became a *manifest variable* (a variable that we actually measure) designed to tease out the underlying latent concept of students' attitude.

Internal validity has three distinct characteristics in quantitative research, which are content validity, criterion validity, and construct validity (Mujis, 2004). Content validity checks whether the content of the *manifest variables* (i.e. the items of the questionnaire) are appropriate to measure the *latent variable* (i.e. students' attitude) that the researcher is trying to measure (Bernard, 2000; Mujis, 2004). To demonstrate this form of validity it is important for the researcher to have a good knowledge of his/her subject and how the concepts he/she is using are theoretically defined (Cohen et al. 2007; Mujis, 2004). Therefore, a researcher can achieve content validity if he/she extensively searches the literature on the concept he/she wants to measure. It is also significant that the researcher asks respondents whether the instrument he/she is using looks valid to them. This form of validity is called *face validity* (Cohen et al. 2007).

In common with content validity, criterion validity is strongly associated with theory. This form of validity attempts to relate the results of one specific instrument (e.g. questionnaire) to another external criterion (Cohen et al. 2007). There are two main forms of criterion validity, which are *predictive validity* and *concurrent validity*. Predictive validity is achieved when the instrument a

researcher uses predicts the outcomes he/she would theoretically expects it to (Mujis, 2004). Concurrent validity is established when the data collected from one instrument correlate highly with the data collected using another instrument (Cohen et al. 2007).

Construct validity is a rather more complex form of validity. In this form of validity it is very important for the researcher to clarify what he/she means when he/she uses a particular construct in his/her research (Cohen et al. 2007; Mujis, 2004). For example, a researcher might want to measure a multidimensional construct (such as attitudes towards mathematics). Therefore, in order to establish construct validity the researcher must be assured that his/her construction of a specific concept agrees with other constructions of the same underlying concept (Cohen et al. 2007). If the researcher wants to measure attitudes towards mathematics then he/she for example will have to develop a measure (e.g. a questionnaire) that will include questions on different subscales. He/she then will need to be sure that items that were supposed to measure for example enjoyment of mathematics (one subscale of attitudes towards mathematics) measured that subscale and not usefulness of mathematics (another subscale of attitudes towards mathematics). In order to do this the researcher will have to use a statistical method called confirmatory factor analysis (see Field, 2005 for details). Confirmatory factor analysis will inform the researcher whether each item of the measure (i.e. questionnaire) that he/she used measured the subscale it was supposed to measure and not any other.

In the present study, content validity was achieved by checking whether the items of the questionnaire used were appropriate to measure attitudes towards mathematics. After I carefully thought of the questions I wanted to ask my participants and defined attitudes towards mathematics, I designed a questionnaire and then administered it to a small sample of students in Cyprus and England and asked them whether the questionnaire I was using seemed appropriate to them for measuring attitudes towards mathematics. By doing this, face validity was accomplished.

In addition, one of the two main criterion validities, concurrent validity, was achieved when after analysing my data the findings of the data collected from the questionnaires agreed with the findings of the data gathered from the interviews. Finally, in order to establish construct validity I clarified early on, what I meant by attitudes towards mathematics in my research and developed a questionnaire that included questions on nine subscales. I then used confirmatory factor analysis (with statistical package for social sciences- SPSS 16.0) and confirmed that each subscale of the questionnaire measured exactly what it was expected to measure.

External validity in quantitative research refers to the degree to which the findings of a study can be generalized to the wider population (Cohen et al. 2007). Researchers are usually interested in generalizing their findings outside of the sample. So, although it can be useful to draw conclusions about a particular

sample of people, it is often more interesting if the researcher can then assume that his/her conclusions are true to a wider population. In order for the researcher to be able to say that his/her findings can be generalized to a wider population he/she will have to minimize his/her chances of making *type I* or *type II error* (Field, 2005; Mujis, 2004). *Type I error* occurs when the researcher believes that there is a genuine effect in his/her population when in fact there isn't, and *type II error* occurs when the researcher believes that there is no effect in the population when in reality there is (Field, 2005). In the present study in order to avoid making *type I error*, instead of using six ANOVAs (analysis of variances) since there were six dependent variables, MANOVA (multivariate analysis of variance) was used (more details are provided in Chapter 6). The findings of this study can only be generalized for the participants of the college in England and the lyceum in Cyprus who were taking advanced mathematics.

Another key concept in quantitative research is reliability. Reliability determines the quality of our measurement instruments and has two main forms in quantitative research, which are *repeated measurement* and *internal consistency*. *Repeated measurement* is a measure of consistency over time and over similar samples (Mujis, 2004). For example, if a researcher decides to measure the same construct in a different chronological period using the same participants and the same instrument, then in order to achieve *repeated measurement* reliability his/her data will have to yield similar results. *Internal consistency* is a form of reliability that is only applicable to instruments that

have more than one item as it concerns how homogeneous the items of a test are or how well they measure a single construct. For example, when developing attitudes towards mathematics scale, a researcher could first see whether the subscales he/she hypothesises exist and are measured by the variables he/she thought they would be. Then for each variable, he/she can check whether the items measure it in a reliable, internally homogeneous way. *Internal consistency* reliability is calculated either by splitting half reliability or by calculating Cronbach's alpha (or otherwise known as coefficient alpha) (Field, 2005). In order to split half reliability supposing a researcher who used an attitude to mathematics measure that consists of thirty items will have to randomly first split the test into two (i.e. the even and uneven items and then calculate the respondents' scores on each "half test". He/she can then check whether the two scores are related to another. If both measure the same thing, then the researcher would expect them to be strongly related with a correlation coefficient of over 0.8. Cronbach's alpha is another measure of *internal consistency* and this measure is expected to be over 0.7 before the researcher can say that his/her test is internally consistent (Field, 2005).

In this study one of the two main forms of reliability was achieved, that is *internal consistency* by calculating Cronbach's alpha. Although the questionnaire designed for this study had nine subscales, only six of the subscales (six attitudinal factors) were considered as the dependent variables measuring students' attitudes towards mathematics (more details are provided in Chapter

6). Cronbach's alpha was applied separately on each of these six subscales. These subscales were: students' enjoyment of mathematics; students' perceptions of their parents' expectations; students' perceptions of their mathematics teacher's expectations; students' perceptions of mathematics as a male domain; students' negative perceptions of their mathematics teacher's expectations; and students' confidence in their mathematical abilities. Cronbach's alpha for each of these six subscales was found respectively: 0.800; 0.776; 0.807; 0.726; 0.749; and 0.768. Because Cronbach's alpha was over 0.7 for each of the six subscales used as the dependent variables, it can be said that each subscale is viable and that the questionnaire used was internally consistent. I should note that because the sample of this study was small and specific, both the external validity and reliability are modest.

In qualitative research, credibility refers to the degree to which the researcher's interpretations are reliable with the ideas and the meanings intended by the participants. Transferability is the extent to which the findings of a research can apply or transfer to other contexts or populations. Dependability refers to the degree that, if the study were conducted again in a similar context with similar participants, the findings would be the same. Confirmability is a measure of how well the findings of a research are supported by the data collected and are not reflections of the researcher's ideas (Lincoln & Guba, 1985).

Lincoln and Guba (1985) proposed several ways for achieving each of these criteria of trustworthiness. To accomplish credibility, long-lasting engagement, triangulation, and member checks are among the ways. Long-lasting engagement means spending enough time in the field to become familiar with the situation and to build trust with the participants so that the researcher can completely understand and appreciate the context. Triangulation refers to multiple methods, sources, or researchers. Member checks, confirmation of the researchers' interpretations with participants, are important in achieving credibility. Transferability can be established with descriptive data that allows an external person to decide whether results transfer to a specific situation. Dependability can be achieved by demonstrating credibility, since there can be no validity without reliability, and through a dependability audit.

To address credibility I spent some time with the participants in order to build trust and getting to know them and I triangulated data sources by using two data sources (questionnaire and interview) to gather supportive evidence of sufficient depth towards findings. Dependability and confirmability of the study were established by creating an audit trail and relying on an independent audit of my research methods by my supervisor. After I completed my data analysis, my supervisor carefully examined my audit trail consisting of the original transcripts and data analysis documents. She then assessed both the dependability and confirmability of the project. Transferability of the project was established through thick description. I did my best to provide significant

detail and rich description regarding all components of the research design so that the reader can decide the transferability of the findings.

5.6 Conducting ethical research

In order to carry out this study in an ethical way, ethical guidelines were taken into consideration and used appropriately. In order to carry the study in Cyprus, it was important to contact the Head of Directorate of Secondary School Teachers (Ministry of Education in Cyprus) in order to ask for her permission to undertake my study in a lyceum (upper secondary school). To do so, a covering letter was sent to her (Appendix 5D) providing the title of my research, introducing myself (the researcher), and providing her with all my contact details, and with an invitation to feel free to contact me for further clarification or details. In addition, I made clear to her the purpose, the importance and the benefits of my research, and explained how I was planning to collect the data and whom I was planning to involve. It was also important to send her a copy of the questionnaire and the interview questions that I was planning to use in order to conduct my research.

The Head of Directorate of Secondary teachers would then send a copy of the questionnaire and the interview questions to a panel of the Centre of Education Research and Evaluation in Cyprus to assess them and make recommendations. I should note that the Centre of Education Research and Evaluation in Cyprus made some recommendations as they thought that some

statements of the questionnaire were negative and some of the interview questions were leading (Appendix 5E). Therefore, a negative statement from the questionnaire, for example, “I don’t think I will use maths very often as an adult” was changed to “I will use maths less as an adult”. In addition, a leading question from the interview such as “What motivates you to do well in mathematics? Is it to enable you to get a good job-a job that you want, to be qualified for university, or to please your parents or yourself? ” was changed to “What motivates you to do well in mathematics”.

As soon as the Head of Directorate of Secondary teachers (Ministry of Education in Cyprus) gave me her official permission (Appendix 5E) in writing to undertake my study, it was then necessary to contact the lyceum that I was planning to carry out my study. It was essential to provide the head teacher of the participating lyceum with the official letter given by the Head of the Directorate of Secondary teachers and explain to her the purpose of my research in order to allow me access to the lyceum. It was also important to talk to the mathematics teachers, explain to them my reasons for conducting this research, and show them both the questionnaire and the interview questions I was planning to use.

In terms of England, it was essential that I first applied for CRB, which checks your criminal record for the safety of children who may participate in the study and may be involved with the researcher. I then had to contact the Head

teacher and the Head of mathematics of the participating college in writing (Appendix 5F), explaining to them the purpose of my study, and whom I wanted to involve in the study, and providing them with the questionnaire and the interview questions I was planning to use to undertake my research project.

Once permissions were given from both the participating lyceum in Cyprus and college in England, I then had to provide the students involved in this examination with a fair explanation of the procedures followed, and their purposes before answering the questionnaire or interview questions. In addition, it was important to inform them that they were free to withdraw consent and to discontinue participation in the project at any time without prejudice to them, and assure them of confidentiality, anonymity and non-traceability. Parental or guardian consent was not considered essential by the Head teacher of the college in England since the participants were of age 17 to 18 years old (although it would have been more polite if parents were notified as well). However, the college Head teacher's consent was obtained considering that he was the person responsible of these students. In Cyprus, the Head teacher of the participating lyceum considered important that the parents of the students were notified. Therefore, letters were sent to them explaining the purpose of the study and promising them confidentiality, anonymity and non-traceability of their children's identities (Appendix 5G).

Finally, all the participants, head teachers, and mathematics teachers were thanked for their collaboration and for making this research project possible.

5.7 Data Analysis

5.7.1 Analysis of questionnaire data

Data analysis of the questionnaire data began once all the data from the questionnaires were collected from the students in Cyprus and England. The questionnaire data were entered on SPSS 16.0 (Statistical Package for Social Sciences). The analysis of the questionnaire data involved both descriptive and inferential statistics. Descriptive statistics were used in order to check that the data were entered correctly, and frequencies were requested from SPSS 16.0 so that I could have initial information about the responses to the items of the questionnaire for the male and female students in Cyprus and England. The first stage of inferential analysis involved Factor Analysis in order to extract the attitudinal factors that would be used as the dependent variables for the study (more details are provided in Chapter 6). The second stage of analysis involved Multivariate Analysis of Variance (MANOVA) using the six factors extracted from Factor Analysis as the dependent variables, and students' gender by country of origin as the independent variable in order to detect differences on the attitudinal factors extracted between the students. The next stage of analysis involved separate Analysis of Variances (ANOVAs) on each of the six dependent variables (six factors extracted) that followed a significant MANOVA. The reason for doing this was to understand the effect

that the dependent variables had on the independent variable (i.e. students' gender by country of origin) and detect for which gender groups this effect was significant (see Chapter 6 for more details). Finally, some *post-hoc* tests were employed in order to allow pairwise comparisons that would help me find out the relationship between the dependent variables and the independent variable.

5.7.2 Analysis of interview data

Student interviews were audio taped for analysis and transcribed immediately after I conducted them from each country. The Greek interview transcripts were translated into English, and the texts from students' interview transcripts were then analysed using thematic analysis (see Chapter 7 for details). In order to identify frequencies of themes for each interviewee and across the whole body of interviewees I adopted a method by Nardi and Steward (2003; see Chapter 7). Consequently, each theme was assigned an ordered pair (x, y) as follows: x corresponds to the number of times the theme has been identified in the coded interview transcript, and y to the number of students who have referred to the theme. The themes emerged from the data were categorised into five theme headings according to commonality and findings from the analysis of interview data were reported and discussed in the five theme headings with tables that illustrated frequencies of each theme by students' gender in each country. Each theme was accompanied by its (x, y)

frequency ordered pair, and discussed using extracts from students' interview transcripts (see Chapter 7 for details).

CHAPTER 6

Findings from Quantitative Analysis

6.1 Outline of Chapter 6

In this chapter, I report on the findings of analysis of data collected using a questionnaire, which was inspired by the Fennema-Sherman Math Attitudes Scales (MAS) and the Attitude Towards Mathematics Inventory (ATMI) by Tapia and Marsh (2004). The questionnaire (see Appendix 5B) was administered to students in Cyprus and England, and contained 32 statements (items) that were formed to examine nine specific attitudinal domains. These domains were: students' perceptions of the relevance of mathematics in their life now and in the future; students' enjoyment of mathematics; students' feelings of anxiety; students' attributions of success or failure in mathematics; students' confidence in their mathematical abilities; students' motivation; students' perceptions of their parents' expectations with regards to mathematics; students' perceptions of their mathematics teacher's expectations; and students' perceptions of mathematics as a male domain.

6.2 Stages of analysis of the questionnaire data

Analysis of the questionnaire data began as soon as all the questionnaire data were collected from the students in Cyprus and England. In England the questionnaires (406 in total) were administered to all the students from the participating college just after they finished their AS examinations and were

collected in the third week of June 2009. The students were asked to indicate in writing at the top of their questionnaire whether they were planning to continue with A-level mathematics or not. Only 43 of the students indicated that they did not intend to do so. Therefore, data collected only from 363 students in England who were intending to take advanced mathematics were entered on SPSS 16.0 (*Statistical Package for Social Sciences*). Questionnaires (62 in total) were also administered to all the students from the participating lyceum in Cyprus who were doing mathematics at advanced level (equivalent to A-level in England) early in September 2009, and were collected the second week of September 2009. As soon as the questionnaires administered to the students in Cyprus were collected, their data were also entered on SPSS and the process of analysis commenced.

6.2.1 Descriptive Statistics-Initial analysis

The initial stage of the analysis involved descriptive statistics in order to check whether the data were entered correctly, and frequencies for male and female students from each country were requested from SPSS 16.0 in order to have initial information regarding their responses to each of the statements (items) of the questionnaire. I then used inferential statistics since the aim of the study was to make comparisons between students of the same gender between the two countries and comparisons between students of the opposite gender within countries on the nine attitudinal domains of the questionnaire. In this chapter, I will present illustrative tables from each stage of the inferential analysis that I

conducted in order to demonstrate how I came to my findings. In addition, some graphs illustrating my findings will be demonstrated.

I would like to note at this point that I initially ran the analysis with all the information collected from 363 students in England and 62 students in Cyprus and followed all the stages, which I will be describing shortly. However, when I reached to the second stage and requested from SPSS to perform a Multivariate Analysis of Variance (MANOVA) it came to my attention that when MANOVA was employed, one of the assumptions under which MANOVA is reliable (that is homogeneity of covariance matrices) was violated. This assumption is examined by testing whether the population variance-covariance of the different groups in the analysis are equal using Box's test. This test should be non-significant ($p\text{-value} > 0.05$) if the matrices are the same. In this case, Box's test was significant and this was due to the unequal group sizes (see Field, 2005 for more details) which consequently would affect the assumptions of robustness of the four MANOVA test statistics (Roy's statistic, Hotelling's trace, Wilk's lambda, and Pillai's trace). In a situation like this there is little to be done, except equalize the samples by randomly deleting cases in the larger groups (Field, 2005). Therefore, because the larger sample of students to whom the questionnaire was administered was the one in England, a decision was made to randomly select data obtained from 50 male and 50 female (100 in total) students in England while retaining all the data collected from the students in Cyprus (30 male and 32 female students). The analysis was conducted again and the assumptions under

which MANOVA is reliable were all robust. I will now describe the stages followed with data collected from 100 questionnaires administered to the students in England, and 62 questionnaires administered to the students in Cyprus.

6.2.2 Inferential Analysis

The first stage of inferential analysis involved Factor Analysis. This process allows the researcher to take a set of variables and reduce them to a smaller number of underlying factors that account for as many variables as possible. It has the power to detect structures and communalities in the relationship between variables and therefore allows us to identify different variables that are addressing the same underlying concept (Field, 2005). For example, the questionnaire had statements (variables) measuring students' enjoyment of mathematics such as "I like mathematics" or "Mathematics is dull and boring". The underlying factor that unites both variables is students' enjoyment of mathematics. I should note at this point that it was essential prior running Factor Analysis on SPSS 16.0 to check whether this type of analysis was appropriate.

The decision of the appropriateness of Factor Analysis for this study was made after testing out that: the variables used in the study were of ordinal level measurement, and normally distributed (the assumptions of normality is most important if we wish to generalize the results of our analysis beyond the sample collected). The relationship between the variables was reasonably linear and the number of participants who provided data was at least one hundred. Because the

items of the questionnaire were designed to measure the same underlying dimension, it was expected that they would correlate with each other (because they are measuring the same thing). Therefore, the intercorrelations between variables were looked at before running the Factor Analysis so that if there were any variables that did not correlate with any other variables to consider excluding them. In this case, all the variables correlated with each other and therefore none of the variables was excluded before running the analysis. This was checked by requesting SPSS 16.0 to create a correlation matrix of all variables (this matrix is available in Appendix 6A). In this matrix, the significance values were looked at and checked for any variable for which the majority of values were greater than 0.05. In addition, the correlation coefficients themselves were looked at and checked for any correlation coefficient greater than 0.9. There was no correlation coefficient greater than 0.9, therefore no singularity in the data. The determinant of the matrix which is listed at the bottom of it was looked at as well and because it was greater than 0.0000001 (Determinant= 0.000000737) we can be confident multicollinearity is not a problem for the data.

Having now tested the appropriateness of Factor Analysis, the variables (items) of the questionnaire were submitted for principal component analysis to reduce the number of variables to a smaller more manageable set. The reliability of Factor Analysis depends on the sample size. Guadagnoli and Velicer (1988) found that the most important factors in establishing reliable factor solutions were the absolute sample size and the magnitude of factor loadings (correlation

coefficients). Briefly, they said that if a factor has four or more loadings greater than 0.6 then it is reliable regardless of sample size. In addition, a factor with ten or more loadings greater than 0.4 is reliable if the sample size is greater than 150. Lastly, factors with few low loadings should not be interpreted unless the sample is 300 or more. MacCallum et al. (1999) also showed that the minimum sample size or sample to variable ratio depends on other aspects of the design of the study. To be more specific, their study showed that as communalities become lower the importance of the sample size increases. With all communalities above 0.6 samples less than 100 may be perfectly adequate. With communalities in the 0.5 range, samples between 100 and 200 can be good enough if there are relatively few factors each with only a small number of indicator variables. If communalities are well below 0.5 and there is a large number of underlying factors, they recommend samples above 500. In addition, Stevens (1992) suggested that: for a sample size 50 a loading of 0.722 can be considered significant; for a sample of 100 the loading should be greater than .512; for 200 it should be greater than .364; for 300 it should be greater than 0.298; for 600 it should be greater than 0.21; and for 1000 it should be greater than 0.162. Hence, when a sample is very large small loadings can be considered statistically meaningful.

Having these guidelines in mind, I requested SPSS before rotation¹ to suppress all the loadings less than 0.512 in the output. At this stage, SPSS 16.0 extracted

¹ Rotation maximizes the loading of each variable on one of the extracted factors whilst minimizing the loading on all other factors. This process makes it much clearer which variables relate to which factors. For

nine factors. However, SPSS extracted these factors using Kaiser's criterion, which is only accurate when the sample size exceeds 250 and the average communality is 0.6 (see Field, 2005). In addition, one of the factors consisted only of one variable and some of the other factors consisted of variables that could not make sense together. Therefore, Factor Analysis was run a few more times specifying SPSS on each occasion to extract a smaller number of factors. The results were compared on each occasion and a decision was made to extract only six factors. After requesting SPSS to extract only six factors, SPSS 16.0 was also asked to conduct an *oblique rotation* where the factor matrix was split into two matrices: the pattern matrix and the structure matrix. The pattern matrix (demonstrated in Table 6.1) contains the factor loadings and the structure matrix takes into account the relationship between factors. In other words, Table 6.1, shows variables (items) of the questionnaire with loadings over 0.512 addressing the same concept clustered together to form an attitudinal factor.

The six factors extracted from Factor Analysis were: students' enjoyment of mathematics; students' perceptions of their parents' expectations with regards to mathematics; students' perceptions of their mathematics teacher's expectations with regards to mathematics; students' perceptions of mathematics as a male domain or not; students' negative perceptions of their mathematics teacher's expectations from them; and students' confidence in their mathematical abilities.

this analysis I used direct oblimin rotation because there were theoretical grounds to suggest that factors could correlate.

These six factors are illustrated in Table 6.1. Each factor is represented by the variables that loaded in it with communalities above 0.512. The variables of the questionnaire are illustrated with codes from Q1 to Q32. For example, Q1 is the first item out of the 32 items of the questionnaire examining students' attitudes towards mathematics (see Appendix 5B).

Table 6.1 Pattern Matrix

Components						
	1	2	3	4	5	6
Q8	-.856					
Q1	.798					
Q17	-.714					
Q6	.555					
Q23		.742				
Q22		-.722				
Q20		.713				
Q25		.656				
Q19		.651				
Q30			.876			
Q31			.756			
Q27			.721			
Q26			.673			
Q15				-.808		
Q12				.675		
Q32					.859	
Q29					.826	
Q28					.734	
Q9						.746
Q5						.708
Q16						.628

I should note that for each of these factors illustrated in Table 6.1 I asked SPSS 16.0 to produce the mean scores for male and female students in each country in order to facilitate an initial understanding of these factors and shed some light into potential differences between the gender groups. Tables with the mean scores will be illustrated later on. In the next stage of analysis, in order to detect differences in the six attitudinal factors extracted between students of opposite gender within countries and between students of the same gender between countries, regression factor scores on the six factors extracted from Factor Analysis were examined as the dependent variables for Multivariate Analysis of Variance (MANOVA) by gender in each country. Multivariate Analysis of Variance (MANOVA) is an extension of Analysis of Variance (ANOVA). It is used in circumstances in which someone is interested in detecting group differences on several dependent variables and in circumstances like these the simple ANOVA model is inadequate. ANOVA is a univariate test and can be used only when there is one dependent variable (Field, 2005).

One may think at this point that if data have been collected about several dependent variables then why not conduct a separate ANOVA for each dependent variable. However, the more tests conducted on the same data, the more the familiwise error rate² is inflated and the greater the chance of making a

² Family wise error rate is the probability of making a *Type I error* in any family of tests when the null hypothesis is true in each case. The ‘family of tests’ can be loosely defined as a set of tests conducted on the same data set and addressing the same empirical question.

*Type I error*³. In addition, MANOVA is more preferable to multiple ANOVAs, because by including all dependent variables in the same analysis the relationship between outcome variables is taken into account. In addition, MANOVA has the power to detect whether groups differ along a combination of dimensions by incorporating information about several outcome measures, and therefore informs us whether groups of participants can be distinguished by a combination of scores on several dependent variables (Field, 2005). Therefore, in this sense MANOVA has greater power to detect an effect, because it can detect whether groups differ along a combination of variables, whereas ANOVA can detect only if groups differ along a single variable.

MANOVA was used in this study with the six factors extracted from Factor Analysis as the dependent variables, and students' gender by country as the independent variable. Before running MANOVA on SPSS, it was essential however to check the assumptions of MANOVA in order to be sure that the resulting multivariate test statistics that would follow would be accurate. MANOVA is reliable when observations are statistically independent, data are randomly sampled from the population of interest and measured at an interval level, the dependent variables have multivariate normality with groups and the population variance-covariance matrices of different groups in the analysis are equal (Field, 2005).

³ *Type I error* occurs when we believe that there is a genuine effect in our population when in fact there isn't.

The assumptions of interval data and independent measures are tested only by common sense. The variables used in the study were of ordinal level measurement. In addition it is reasonable to assume that data from different participants collected from each country is independent, because the behaviour of one participant does not influence the behaviour of another (in other words the answers given by one participant to the questions of the questionnaire does not influence the answers given by another participant). The assumption of multivariate normality could not be tested on SPSS, and therefore the only practical and useful solution was to test out the assumption of univariate normality (because univariate normality is a necessary condition for multivariate normality) for each dependent variable in turn. This was tested by plotting frequency distributions for each dependent variable and seeing whether the distribution of the sample data was normal (the curve should be bell-shaped if the sample data is normally distributed). The frequency distributions for each dependent variable of the sample data of this study were fairly normal.

Finally, the assumption of equality of covariance matrices was more easily tested. First, for this assumption to be true the univariate tests of equality of variances should be met. This can be easily checked using Levene's test which should be non-significant for any of the dependent variables ($p\text{-value} > 0.05$). Levene's test, however, does not take account of the covariances, and therefore the variance-covariance matrices should be compared between groups using Box's test. This test should be non-significant ($p\text{-value} > 0.05$) if the matrices are

the same (Field, 2005). Levene's test for each of the dependent variables of the study was non-significant (see Table 6.2) and Box's test for the sample of 162 students from both countries was also non-significant.

Table 6.2 Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Enjoyment of mathematics	2.775	3	158	.054
Students' perceptions of their parents' expectations	1.534	3	158	.208
Students' perceptions of their mathematics teacher's expectations	1.320	3	158	.270
Students' perceptions of mathematics as a male domain or not	.774	3	158	.510
Students' negative perceptions of their mathematics teacher's expectations	2.479	3	158	.063
Students' confidence in their mathematical abilities	.142	3	158	.934

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + gender

Levene's test of equality of variances for each of the dependent variables is illustrated in Table 6.2. These tests are the same as would be found if one-way Analysis of variance had been conducted on each dependent variable in turn.

Looking at the table Levene's test is non-significant for all the dependent variables (sig. or $p\text{-value} > 0.05$), therefore the assumption of homogeneity of variance has been met. We can now be confident in the reliability of the univariate tests to follow, and we can assume that the multivariate test statistics (illustrated in Table 6.3) are robust.

Pillai's trace multivariate test statistic was employed for F statistic for this study. All four multivariate test statistics are demonstrated in Table 6.3. Pillai's trace was considered best for this study in terms of power and robustness. The reason for choosing Pillai's trace over any other multivariate test statistic was that groups in this study differ along more than one variate (a variate is a linear combination of the dependent variable). When this happens, Pillai's trace is most powerful and Roy's root is least (there is an extensive work on the power of the four MANOVA test statistics by both Olson 1974, 1976, 1979, and Stevens 1979).

Table 6.3 Multivariate Tests

Effect	Value	F	Hypothesis df	Error df	Sig.
Gender Pillai's Trace	.308	2.951	18.000	465.000	.000
Wilk's Lambda	.714	3.042	18.000	433.235	.000
Hotelling's Trace	.370	3.117	18.000	455.000	.000
Roy's Largest Root	.256	6.620 ^b	6.000	155.000	.000

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

Looking at this table, because the significance value is smaller than 0.05 ($p\text{-value} < 0.05$, $F(18, 465) = 2,951$, Pillai's Trace = 0.308) for Pillai's Trace it means that the effect that the dependent variables have on the independent variable (students' gender by country of origin) is significant and to expect differences between groups. However, the nature of this effect is not clear from the multivariate test statistic alone, because we don't know which gender groups (i.e. male-female students in England; male-female students in Cyprus; male students in England-male students in Cyprus; female students in England-female students in Cyprus) differed from which and we don't know whether the impact of attitudinal factors on gender groups were on behalf of factor 1, 2, 3, 4, 5 or 6. To determine the nature of the impact of attitudinal factors on gender (the independent variable) I requested SPSS 16.0 to produce some univariate tests.

For this study, separate ANOVAs on each of the dependent variables followed a significant MANOVA. The idea behind this is that the overall multivariate test protects against inflated Type I error rates, because if that initial test is non-significant (i.e. the null hypothesis is true) then any subsequent tests are ignored (any significance must be a Type I error because the null hypothesis is true). On the other hand, the idea of protection is rather misleading, because a significant MANOVA often reflects a significant difference for one but not all of the dependent variables. Subsequent ANOVAs are then carried out on all the dependent variables, but the MANOVA protects only the dependent variable for

which group differences genuinely exist (see Bray & Maxwell, 1985, pp.40-41 for more details).

The next stage was to look at the univariate ANOVA test statistics in order to find out which of the dependent variables were contributing to the significant overall result. It was important, however, before making any conclusions in order to control the familywise error and avoid the possibility of committing a Type I error to apply a Bonferroni correction. This was done by dividing the overall Type I error rate (α) by the number of comparisons ensuring that the cumulative Type I error was below 0.05. In this study because I had six dependent variables and I wanted to look at six ANOVAs performed on these dependent variables I divided α by 6 ($0.05 \div 6 = 0.008$). I then used 0.008 as my criterion of significance meaning that the *p-value* should be less than 0.008 to consider a result as significant. Looking at the univariate ANOVA tests illustrated in Table 6.4, significant differences between gender-groups were evident only on two of the dependent variables, that of students' perceptions of their parents' expectations with regards to mathematics (*p-value*=0.006) and that of students' perceptions of mathematics as a male domain or not (*p-value*=0.000). More tests, however, needed to be carried out in order to see between which gender-groups (i.e. male-female students in Cyprus, female students in Cyprus-female students in England, etc.) these differences were statistically important.

Table 6.4 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Attitudinal Factor1	.397 ^a	3	.132	.130	.942
	Factor2	12.304 ^b	3	4.101	4.358	.006
	Factor3	6.971 ^c	3	2.324	2.384	.071
	Factor4	27.768 ^d	3	9.256	10.977	.000
	Factor5	2.776 ^e	3	.925	.924	.431
	Factor6	1.983 ^f	3	.661	.657	.580
Intercept	Attitudinal Factor1	.008	1	.008	.008	.929
	Factor2	.626	1	.626	.666	.416
	Factor3	.379	1	.379	.389	.534
	Factor4	.041	1	.041	.048	.827
	Factor5	.129	1	.129	.129	.720
	Factor6	.021	1	.021	.021	.886
Gender	Attitudinal Factor1	.396	3	.132	.130	.942
	Factor2	12.304	3	4.101	4.358	.006
	Factor3	6.971	3	2.324	2.384	.071
	Factor4	27.768	3	9.256	10.977	.000
	Factor5	2.776	3	.925	.924	.431
	Factor6	1.983	3	.661	.657	.580

a. R Squared = .002 (Adjusted R Squared = -.016) b. R Squared = .076 (Adjusted R Squared = .059)

c. R Squared = .043 (Adjusted R Squared = .025) d. R Squared = .172 (Adjusted R Squared = .157)

e. R Squared = .017 (Adjusted R Squared = -.001) f. R Squared = .012 (Adjusted R Squared = -.006)

My final stage of analysis involved some *post-hoc* tests. These tests were employed because they allow pairwise comparisons that will help me find out the

relationship between the dependent variables (six attitudinal domains) and the independent variable (students' gender by country of origin). For my study I used Gabriel's pairwise test procedure because the sample sizes (students' sample in England and students' sample in Cyprus) were unequal, however, slightly imbalanced. Gabriel's pairwise test procedure is designed to cope with situations in which sample sizes are different and it is more powerful than Hochberg's GT2 pairwise test procedure which also copes well when sample sizes are unequal (Field, 2005).

I will now demonstrate in the tables that follow pairwise comparisons of students' gender-groups for each of the dependent variable using Gabriel's procedure. Each of these tables is accompanied by another table, which illustrates the mean scores of students' responses to the variables (items of the questionnaire) that formed each dependent variable (attitudinal factor). Because the univariate ANOVA tests illustrated earlier in Table 6.4 showed significant differences between gender-groups only on "students' perceptions of their parents' expectations with regards to mathematics", and "students' perceptions of mathematics as a male domain or not", I will explain these differences between the gender-groups by presenting some graphs and tables with students' responses (in percentages) to the specific variables (items) that formed the two of the attitudinal factors.

6.2.2.1 Students' enjoyment of mathematics

Table 6.5(a) Multiple Comparisons (*post-hoc tests*) Dependent variable: “Students’ enjoyment of mathematics”

	(I) students’ gender in each country	(J) students’ gender in each country	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gabriel	English male	English female	.0988282	.20164131	.997	-.4381227	.6357790
		Cypriot male	-.0261425	.23283532	1.000	-.6412182	.5889332
		Cypriot female	.0039453	.22824246	1.000	-.6001244	.6080150
	English female	English male	-.0988282	.20164131	.997	-.6357790	.4381227
		Cypriot male	-.1249707	.23283532	.995	-.7400464	.4901051
		Cypriot female	-.0948829	.22824246	.999	-.6989526	.5091869
	Cypriot male	English male	.0261425	.23283532	1.000	-.5889332	.6412182
		English female	.1249707	.23283532	.995	-.4901051	.7400464
		Cypriot female	.0300878	.25621806	1.000	-.6521068	.7122824
	Cypriot female	English male	-.0039453	.22824246	1.000	-.6080150	.6001244
		English female	.0948829	.22824246	.999	-.5091869	.6989526
		Cypriot male	-.0300878	.25621806	1.000	-.7122824	.6521068

Based on observed means. The error term is Mean Square (Error) = 1.006.

*. The mean difference is significant at the .05 level.

Looking at the significance (Sig.) column of this table it is clear that there is not a *p-value* which is smaller than 0.05. This means that for the dependent variable “Students’ enjoyment of mathematics” there are no differences between any of the gender groups. This is not a surprise as no difference was expected to be found based on the ANOVA test statistics results illustrated on the previous table.

Table 6.5 (b) Mean scores for “Students’ enjoyment of mathematics”

Mean Scores for:	English male	English female	Cypriot male	Cypriot female
Mathematics is dull and boring	2.20	2.12	2.30	2.09
I like mathematics	4.12	3.96	4.10	3.88
I would like to avoid mathematics at university	2.32	2.22	2.40	2.19
I would like to use mathematics at university	3.60	3.20	3.73	4.03

Table 6.5 (b) confirms that for the dependent variable “Students’ enjoyment of mathematics” there was no statistically significant difference between any of the gender groups. The mean scores for each statement are only marginally different between any of the gender groups. A noticeable and interesting difference, however, is evident between female students in England and female students in Cyprus regarding the statement “I would like to use mathematics at university”. It seems that female students in England were neutral with this statement (score 3 corresponds to ‘neither agree nor disagree’ on the scale of the questionnaire), whereas female students in Cyprus ‘agreed’ (score 4 corresponds to ‘agree’ on the scale of the questionnaire) with it. Moreover, it seems that male students in Cyprus and England agreed with the statement ‘I like mathematics’, whereas female students in each country tended to ‘agree’ with it. Therefore, the mean scores suggest that female students in Cyprus felt more strongly about using mathematics at university than female students in England. Male students in Cyprus and England, on the other hand, felt more strongly about liking mathematics compared to the female students in England and Cyprus.

6.2.2.2 Students' perceptions of their parents' expectations with regards to mathematics

Table 6.6 (a) Multiple Comparisons (*post-hoc tests*) Dependent variable: "Students' perceptions of their parents' expectations with regards to mathematics"

	(I) students' gender in each country	(J) students' gender in each country	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gabriel	English male	English female	.1944931	.19402212	.897	-.3221686	.7111548
		Cypriot male	-.4538581	.22403744	.229	-1.0456926	.1379765
		Cypriot female	-.4414830	.21961812	.239	-1.0227275	.1397614
	English female	English male	-.1944931	.19402212	.897	-.7111548	.3221686
		Cypriot male	-.6483512*	.22403744	.024	-1.2401857	-.0565166
		Cypriot female	-.6359761*	.21961812	.024	-1.2172206	-.0547317
	Cypriot male	English male	.4538581	.22403744	.229	-.1379765	1.0456926
		English female	.6483512*	.22403744	.024	.0565166	1.2401857
		Cypriot female	.0123750	.24653664	1.000	-.6440423	.6687923
	Cypriot female	English male	.4414830	.21961812	.239	-.1397614	1.0227275
		English female	.6359761*	.21961812	.024	.0547317	1.2172206
		Cypriot male	-.0123750	.24653664	1.000	-.6687923	.6440423

Based on observed means. The error term is Mean Square (Error) = 1.006.

*. The mean difference is significant at the .05 level.

Looking now at the significance (Sig.) column some of the *p-values* which I highlighted with grey are less than 0.05 (*p-values*=0.024). Looking at the same time at the rows in which these differences are highlighted it is obvious that there are statistically significant differences in students' perceptions of their parents' expectations with regards to mathematics between female students in England

and male students in Cyprus, and between female students in England and female students in Cyprus. However, because in this study my intention was to compare students of the same gender between Cyprus and England I will hold on to the difference found between female students in England and female students in Cyprus and not to the difference found between female students in England and male students in Cyprus.

Table 6.6 (b) Mean scores for “Students’ perceptions of their parents’ expectations with regards to mathematics”

Mean Scores for:	English male	English female	Cypriot male	Cypriot female
My parents think mathematics will help me get a good job	4.08	3.90	4.50	4.09
My parents think is not very important to do well in mathematics	1.84	1.82	1.63	1.69
My parents expect me to do well in mathematics	4.18	4.02	4.13	4.22
My parents think I will need maths for my future career	3.72	3.72	4.43	4.50
My parents have been always interested in my progress in maths	3.90	3.86	4.17	4.38

Looking at Table 6.6 (b) male students in Cyprus tended to ‘strongly agree’ with the statement “My parents think mathematics will help me get a good job”, whereas female students in England tended to ‘agree’ with it. It should be noted that the mean scores for male students in England, female students in England, and female students in Cyprus regarding this statement were only marginally different. In addition, concerning the statement “My parents think mathematics will help me with my future career”, both male and female students in Cyprus

tended to 'strongly agree' with it, whereas male and female students in England were inclined to 'agree' with it. The difference between the mean scores for students in Cyprus and the mean scores for students in England in this statement is significant. Moreover, regarding the statement "My parents have been always interested in my progress in mathematics", female students in Cyprus tended to 'strongly agree' and female students in England tended to 'agree'. To sum up, there are some interesting cultural differences suggesting that female students in Cyprus perceived their parents to think that they will need mathematics for their future career and to have always been interested in their progress in maths more strongly compared to female students in England. In addition, it seems that there were no statistically significant differences in "students' perceptions of their parents' expectations with regards to mathematics" between male and female students in Cyprus. The same applies between male and female students in England.

6.2.2.3 Students' perceptions of their mathematics teacher's expectations with regards to mathematics

Table 6.7 (a) Multiple Comparisons (post-hoc tests) Dependent variable: "Students' perceptions of their mathematics teacher's expectations with regards to mathematics"

	(I) students' gender in each country	(J) students' gender in each country	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gabriel	English male	English female	-.0302520	.19747061	1.000	-.5560967	.4955927
		Cypriot male	-.4308828	.22801942	.302	-1.0332365	.1714709
		Cypriot female	-.4505458	.22352156	.236	-1.0421211	.1410295

	English female	English male	.0302520	.19747061	1.000	-.4955927	.5560967
		Cypriot male	-.4006308	.22801942	.385	-1.0029844	.2017229
		Cypriot female	-.4202938	.22352156	.309	-1.0118691	.1712815
	Cypriot male	English male	.4308828	.22801942	.302	-.1714709	1.0332365
		English female	.4006308	.22801942	.385	-.2017229	1.0029844
		Cypriot female	-.0196630	.25091851	1.000	-.6877473	.6484212
	Cypriot female	English male	.4505458	.22352156	.236	-.1410295	1.0421211
		English female	.4202938	.22352156	.309	-.1712815	1.0118691
		Cypriot male	.0196630	.25091851	1.000	-.6484212	.6877473

Based on observed means. The error term is Mean Square (Error) = 1.006.

*. The mean difference is significant at the .05 level.

It is clear from Table 6.7 (a) by looking at the significance (Sig.) column that students' perceptions of their mathematics teacher's expectations with regards to mathematics did not have a significant effect on any of the gender-groups and that there weren't any significant differences between them.

Table 6.7 (b) Mean scores for "Students' perceptions of their mathematics teachers' expectations with regards to mathematics"

Mean Scores for:	English male	English female	Cypriot male	Cypriot female
My mathematics teacher thinks it is very important that I do well in mathematics	4.00	4.04	4.33	4.47
My mathematics teacher thinks mathematics will help me get a good job	3.92	3.72	4.30	4.38
My mathematics teacher expects me to do my best at all time in mathematics	4.00	4.14	4.17	4.19
My mathematics teacher believes in my mathematical abilities	3.64	3.65	4.00	4.00

Table 6.7 (b) confirms that there weren't any significant differences in students' perceptions of their mathematics teacher's expectations with regards to mathematics between any of the gender groups. There was an evident trend, however, between students in Cyprus and students in England regarding the statement "My mathematics teacher thinks mathematics will help me get a good job". Male and female students in Cyprus tended to 'strongly agree', whereas male and female students in England tended to 'agree' with this statement. It seems that female students in England felt less strong with this statement compared to the other students. Another noticeable trend between students in Cyprus and students in England was regarding the statement "My mathematics teacher believes in my mathematical abilities". Male and female students in Cyprus agreed, whereas male and female students in England tended to agree with this statement.

6.2.2.4 Students' perceptions of mathematics as a male domain

Table 6.8 (a) Multiple Comparisons (*post-hoc tests*) Dependent variable: "Students' perceptions of mathematics as a male domain"

	(I) students' gender in each country	(J) students' gender in each country	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gabriel	English male	English female	.8306074*	.18365642	.000	.3415485	1.3196663
		Cypriot male	-.0877269	.21206817	.999	-.6479425	.4724887
		Cypriot female	.7261576*	.20788495	.003	.1759663	1.2763488
	English female	English male	-.8306074*	.18365642	.000	-1.3196663	-.3415485
		Cypriot male	-.9183343*	.21206817	.000	-1.4785499	-.3581187
			-.1044498				.4457414

		Cypriot female		.20788495	.997	-.6546411	
	Cypriot male	English male	.0877269	.21206817	.999	-.4724887	.6479425
		English female	.9183343*	.21206817	.000	.3581187	1.4785499
		Cypriot female	.8138845*	.23336534	.004	.1925365	1.4352325
	Cypriot female	English male	-.7261576*	.20788495	.003	-1.2763488	-.1759663
		English female	.1044498	.20788495	.997	-.4457414	.6546411
		Cypriot male	-.8138845*	.23336534	.004	-1.4352325	-.1925365

Based on observed means. The error term is Mean Square (Error) = 1.006.

*. The mean difference is significant at the .05 level.

Table 6.8 (a) shows significant statistical differences in students' perceptions of mathematics as a male domain between male and female students in England, between male students in England and female students in Cyprus, between male students in Cyprus and female students in England and finally between male and female students in Cyprus. Because the aim of the study was to compare students of the same gender between countries and students of the opposite gender within countries I will retain from this table's findings only that there were significant statistical differences in students' perceptions of mathematics as a male domain between male and female students in England and between male and female students in Cyprus.

Table 6.8 (b) Mean scores for “Students’ perceptions of mathematics as a male domain”

Mean Scores for:	English male	English female	Cypriot male	Cypriot female
Female students are as good as male students when solving a maths problem	3.08	4.24	3.13	4.03
Male students are better at maths than female students	3.38	2.16	3.40	1.72

Table 6.8 (b) confirms the significant differences demonstrated in Table 6.8 (a). Specifically, both female students in England and Cyprus tended to ‘strongly agree with the statement “Female students are as good as male students when solving maths problems”’, whereas both male students in England and Cyprus were neutral with it. Moreover, both male students in England and male students in Cyprus tended to ‘agree’ with the statement “Male students are better at maths than female students”, whereas female students in England ‘disagreed’ and female students in Cyprus ‘strongly disagreed’ with it.

6.2.2.5 Students’ negative perceptions of their mathematics teacher’s expectations with regards to mathematics

Table-6.9 (a) Multiple Comparisons (*post-hoc tests*) Dependent variable: “Students’ negative perceptions of their mathematics teacher’s expectations with regards to mathematics”

	(I) students’ gender in each country	(J) students’ gender in each country	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gabriel	English male	English female	.1239513	.20014180	.990	-.4090065	.6569091

		Cypriot male	.3592613	.23110384	.529	-.2512404	.9697630
		Cypriot female	.2477057	.22654513	.849	-.3518718	.8472832
	English female	English male	-.1239513	.20014180	.990	-.6569091	.4090065
		Cypriot male	.2353101	.23110384	.886	-.3751916	.8458118
		Cypriot female	.1237544	.22654513	.995	-.4758231	.7233320
	Cypriot male	English male	-.3592613	.23110384	.529	-.9697630	.2512404
		English female	-.2353101	.23110384	.886	-.8458118	.3751916
		Cypriot female	-.1115556	.25431269	.998	-.7886771	.5655658
	Cypriot female	English male	-.2477057	.22654513	.849	-.8472832	.3518718
		English female	-.1237544	.22654513	.995	-.7233320	.4758231
		Cypriot male	.1115556	.25431269	.998	-.5655658	.7886771

Based on observed means. The error term is Mean Square (Error) = 1.006.

*. The mean difference is significant at the .05 level.

Looking at Table 6.9 (a) and at the significance (Sig.) column it is clear that there are no *p-values* that are less than 0.05. Therefore, there were no statistically significant differences between gender-groups on their negative perceptions of their mathematics teacher's expectations.

Table 6.9 (b) Mean scores for "Students' negative perceptions of their mathematics teacher's expectations with regards to mathematics"

Mean Scores for:	English male	English female	Cypriot male	Cypriot female
My mathematics teacher thinks it is not very important to do well in mathematics	1.88	1.64	1.70	1.78
My mathematics teacher thinks I will not need mathematics in my future career	2.30	2.24	1.70	1.62
My mathematics teacher thinks I am not very good at mathematics	2.38	2.38	2.23	2.53

Table 6.9 (b) confirms no significant differences between any of the gender groups concerning the statement “Students’ negative perceptions of their mathematics teacher’s expectations”. An evident trend, however, is between students in Cyprus and students in England regarding the statement “My mathematics teacher thinks I will not need mathematics in my future career”. Specifically, male and female students in Cyprus tended to ‘strongly disagree’, whereas male and female students in England disagreed with it. These mean scores suggest that the students in Cyprus perceived their mathematics teacher to think that mathematics was important for their future career more strongly compared to the students in England. As demonstrated earlier, female students in England also felt less strong about their mathematics teacher thinking that mathematics will help them get a good job compared to any of the other students in England and Cyprus. These perceptions perhaps play a significant role in the career choices of female students in England.

6.2.2.6 Students’ confidence in their mathematical abilities

Table 6.10 (a) Multiple Comparisons (*post-hoc* tests) Dependent variable: “Students’ confidence in their mathematical abilities”

	(I) students’ gender in each country	(J) students’ gender in each country	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gabriel	English male	English female	.2492706	.20064239	.764	-.2850203	.7835614
		Cypriot male	-.0089650	.23168188	1.000	-.6209937	.6030636
		Cypriot female	.0672577	.22711176	1.000	-.5338196	.6683349
	English female	English male	-.2492706	.20064239	.764	-.7835614	.2850203

		Cypriot male	-.2582356	.23168188	.836	-.8702643	.3537931
		Cypriot female	-.1820129	.22711176	.961	-.7830901	.4190643
	Cypriot male	English male	.0089650	.23168188	1.000	-.6030636	.6209937
		English female	.2582356	.23168188	.836	-.3537931	.8702643
		Cypriot female	.0762227	.25494877	1.000	-.6025923	.7550377
	Cypriot female	English male	-.0672577	.22711176	1.000	-.6683349	.5338196
		English female	.1820129	.22711176	.961	-.4190643	.7830901
		Cypriot male	-.0762227	.25494877	1.000	-.7550377	.6025923

Based on observed means. The error term is Mean Square (Error) = 1.006.

*. The mean difference is significant at the .05 level.

Looking at Table-6.10 (a) and at the significance (Sig.) column it is obvious that there aren't any significant statistical differences on students' confidence in their mathematical abilities between any of the gender-groups as there aren't any *p-values* smaller than 0.05. This, however, was expected based on the results of the univariate ANOVA test statistics shown in Table 6.4.

Table 6.10 (b) Mean scores for "Students' confidence in their mathematical abilities"

Mean Scores for:	English male	English female	Cypriot male	Cypriot female
I am able to solve mathematics problems without too much difficulty	3.28	3.22	3.63	3.56
I am good at mathematics	3.78	3.44	3.97	4.06
I do well in maths because I am naturally good at it	3.36	3.12	3.37	3.03

Table 6.10 (b) confirms no statistically significant differences between any of the gender groups regarding the statement "Students' confidence in their

mathematical abilities". A noticeable trend, however, was between female students in Cyprus and male students in Cyprus, and between female students in Cyprus and male and female students in England regarding the statement "I am good at mathematics". Specifically, female students in Cyprus 'agreed', and male and female students in England and male students in Cyprus tended to 'agree' with this statement. It is worth noting that male students in England were inclined to 'agree' with this statement more than female students in England were. In addition, it seems that female and male students in Cyprus felt more strongly with the statement "I am able to solve mathematics problems without too much difficulty" than male and female students in England did. A possible explanation for this might be that students in England are traditionally more reserved compared to students in Cyprus. Nevertheless, female students in Cyprus came across as more confident in their mathematical abilities compared to female students in England. Perhaps their confidence in their mathematical abilities can explain their less stereotypical views of mathematical ability shown earlier.

I will now elucidate further the statistically significant differences found earlier in the two attitudinal factors using graphs and tables with students' responses in percentages. These statistically significant differences found were in "students' perceptions of mathematics as a male domain" between male and female students in England, and between male and female students in Cyprus, and in "students' perceptions of their parents' expectations with regards to mathematics" between female students in England and female students in Cyprus.

6.2.2.7 Statistically significant differences

Figure 6.1 Students' responses in percentages on the variable "Female students are as good as male students when solving a maths problem"

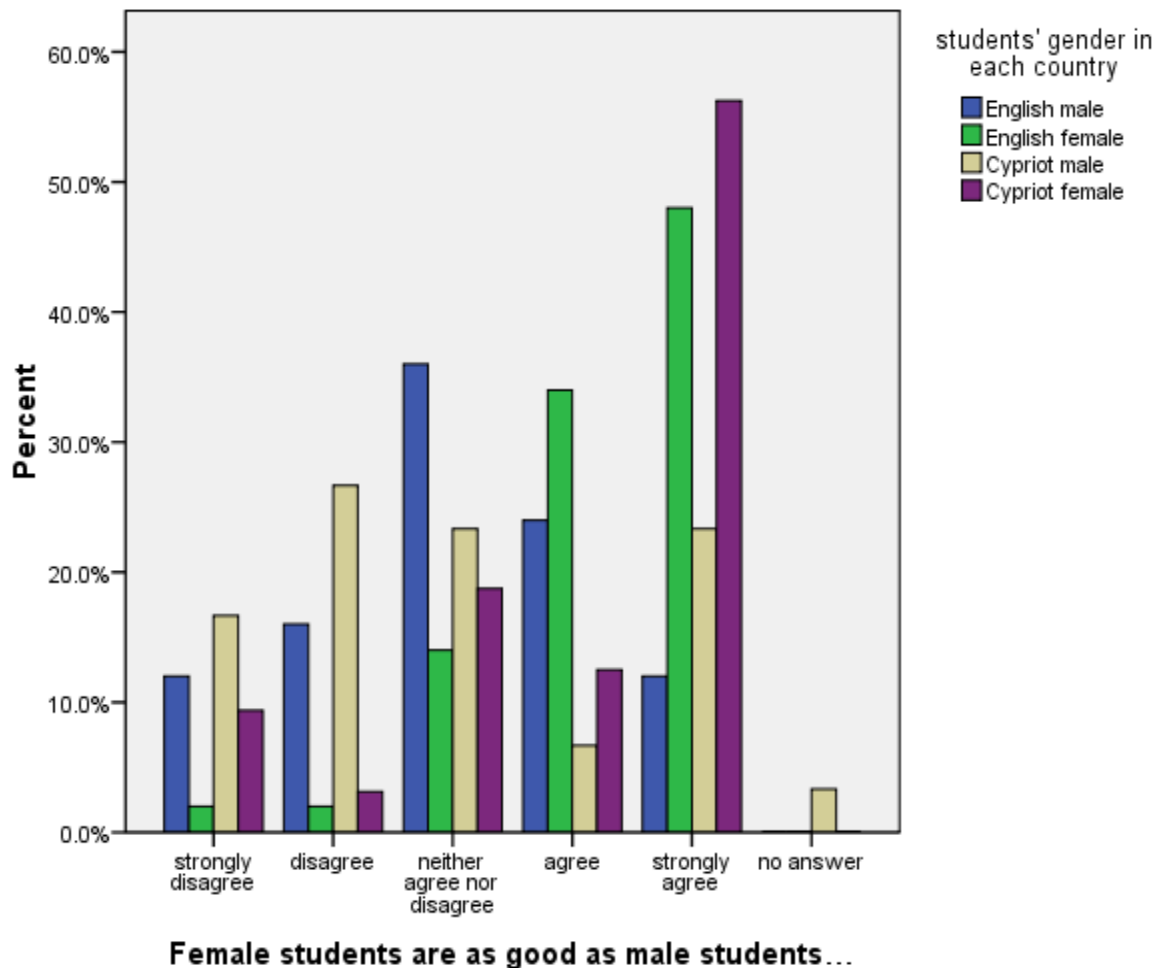


Table 6.11 Female students are as good as male students when solving a maths problem

		English male	English female	Cypriot male	Cypriot female
Valid	Strongly disagree	12.0	2.0	16.7	9.4
Percent	Disagree	16.0	2.0	26.7	3.1
	Neither agree nor disagree	36.0	14.0	23.3	18.8
	Agree	24.0	34.0	6.7	12.5
	Strongly agree	12.0	48.0	23.3	56.2
	No answer	0	0	3.3	0
	Total	100.0	100.0	100.0	100.0

Significant statistical differences as demonstrated earlier were found in “students’ perceptions of mathematics as a male domain or not” between male and female students in England and male and female students in Cyprus. One of the two variables that formed this attitudinal factor was “female students are as good as male students when solving a maths problem”. Looking at both Figure 6.1 and Table 6.11 it is obvious that male and female students in each country had different opinions about this statement. For example, 36% of the male students in England ‘neither agreed nor disagreed’ with this statement and another 36% (including the percentages of ‘strongly agree’) of them agreed with it. On the other hand, 82% of the female students in England agreed with this statement and only 4% of them disagreed.

In terms of the students in Cyprus, 30% of the male students in Cyprus agreed with this statement and 43.4% (the majority) of them disagreed with it. Similar to the female students in England, most of the female students in Cyprus (68.7%) agreed and only 12.5% of them ‘disagreed’ with this statement. It is clear from students’ responses (in percentages) that most of the male students in Cyprus did not perceive female students to be as good as male students when solving mathematics problems, whereas male students in England did not support this view as strongly as the male students in Cyprus did. On the other hand, both female students in Cyprus and female students in England supported this view. It should be noted that although the percentage of the female students in England

(82%) was higher than the percentage of the female students in Cyprus (68.7%) who agreed with the statement “female students are as good as male students when solving mathematics problems” these percentages were a combination of ‘agree’ and ‘strongly agree’ responses. Female students in Cyprus (56.2%) more often than female students in England (48%) ‘strongly agreed’ with this statement.

The attitudinal factor “Students’ perceptions of mathematics as a male domain” was also formed by the variable “male students are better at mathematics than female students”. Figure 6.2 and Table 6.12, show students’ responses in percentages regarding this statement.

Figure 6.2 Students' responses in percentages on the variable "Male students are better at mathematics than female students"

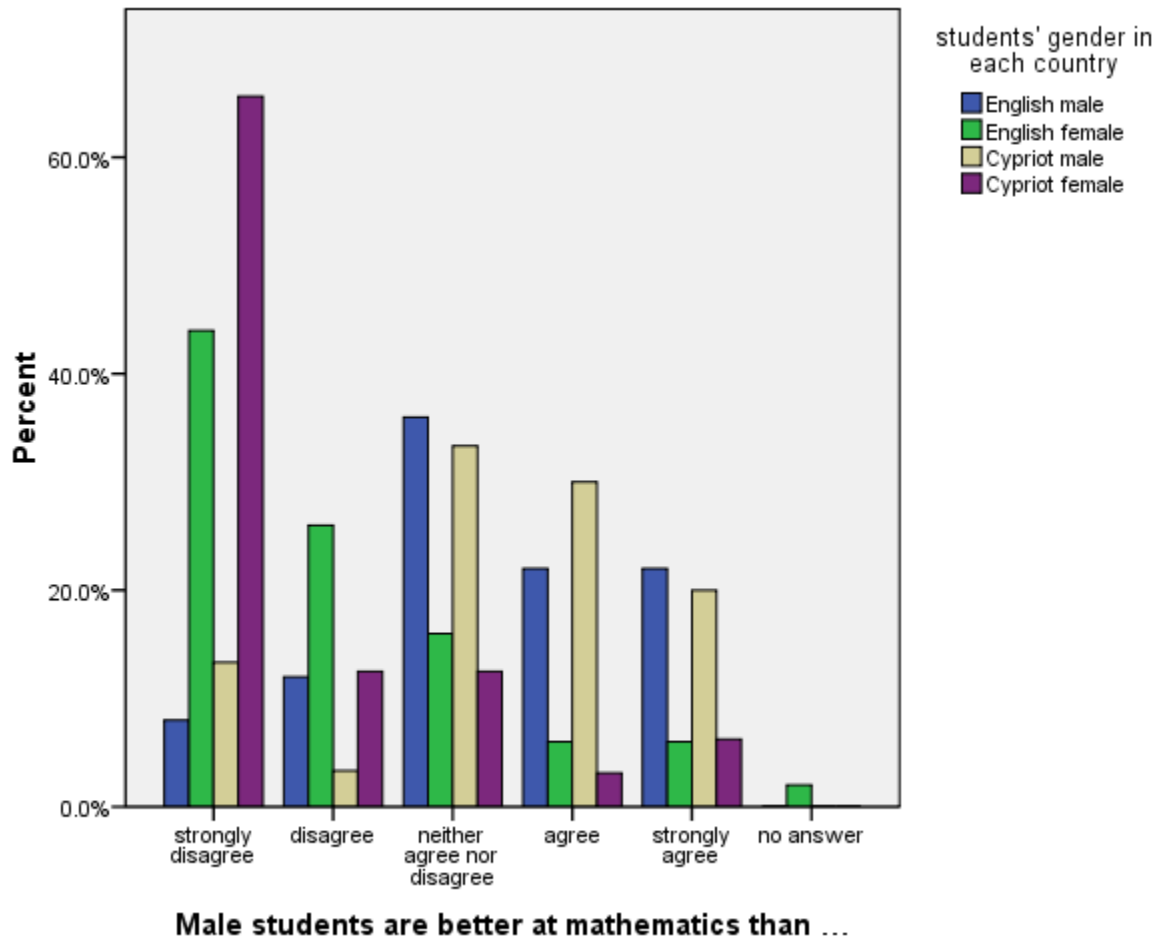


Table 6.12 Male students are better at mathematics than female students

		English male	English female	Cypriot male	Cypriot female
Valid	Strongly disagree	8.0	44.0	13.3	65.6
Percent	Disagree	12.0	26.0	3.3	12.5
	Neither agree nor disagree	36.0	16.0	33.3	12.5
	Agree	22.0	6.0	30.0	3.1
	Strongly agree	22.0	6.0	20.0	6.2
	No answer	0	2.0	0	0
	Total	100.0	100.0	100.0	100.0

Looking at both Figure 6.2 and Table 6.12 once again male students in each country had a different opinion to female students in each country regarding the statement “male students are better at mathematics than female students”. The majority of the male students in England (44%) agreed with this statement and only 20% disagreed with it. The majority of the girls in England (70%), however, disagreed with this statement and only 12% of them agreed with it. This trend was very similar with the students in Cyprus. For example, 50% of the male students in Cyprus agreed and only 16.6% of them disagreed with this statement and 78.1% of the female students in Cyprus disagreed with it, whereas 9.3% of the girls in Cyprus agreed. It should be noted that the percentage of the female students in Cyprus who ‘strongly disagreed’ with this statement was higher than the percentage of the female students in England who also ‘strongly disagreed’ with it. As demonstrated earlier (see Table 6.10), female students in Cyprus felt more strongly about their mathematical abilities than female students in England did. It can be assumed that female students in Cyprus did not perceive that boys were better at mathematics than girls were, because they perceived that boys and girls were of the same abilities in mathematics or that girls were better than boys were at mathematics.

The second attitudinal factor for which the statistical analysis revealed significant differences between female students in England and female students in Cyprus, and female students in England and male students in Cyprus was “Students perceptions’ of their parents’ expectations with regards to mathematics”. This

attitudinal factor was formed by five variables: my parents think mathematics will help me get a good job; my parents think it is not important to do well in mathematics; my parents expect me to do well in mathematics; my parents think I will need mathematics for my future career; and my parents have been always interested in my progress in mathematics. Because the study intended to make comparisons between students of the same gender between the two countries, I will now focus on the statistically significant differences found between female students in Cyprus and female students in England concerning their parents' expectations with regards to mathematics. I will illustrate their responses in percentages on each of the five statements (variables) that formed this attitudinal factor using graphs and tables.

Figure 6.3 Female students' responses in percentages on the variable "My parents think mathematics will help me get a good job"

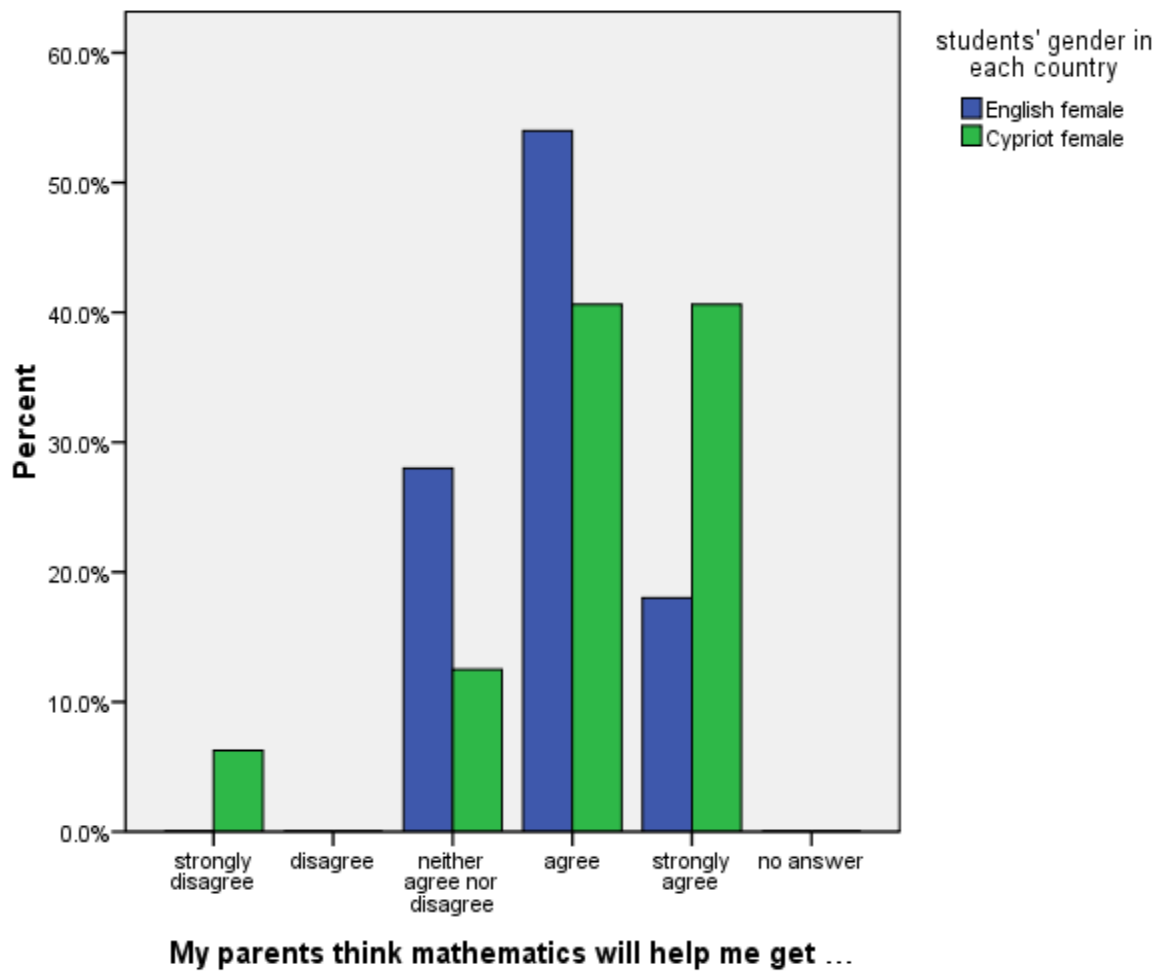


Table 6.13 My parents think mathematics will help me get a good job

		English female	Cypriot female
Valid	Strongly disagree	0	6.2
Percent	Disagree	0	0
	Neither agree nor disagree	28.0	12.5
	Agree	54.0	40.6
	Strongly agree	18.0	40.6
	No answer	0	0
	Total	100.0	100.0

From both Figure 6.3 and Table 6.13 it is clear that more female students in Cyprus (81.2%) agreed with the statement “my parents think mathematics will help me get a good job” than female students in England (72%). An interesting trend is that female students in Cyprus more often than female students in England ‘strongly agreed’ with this statement. For example, the percentage of female students in Cyprus (40.6%) who ‘strongly agreed’ with this statement was more than double the percentage of female students in England (18%). In addition, more female students in England (28%) than female students in Cyprus (12.5%) were neutral with this statement. It is worth noting also that a small percentage of female students in Cyprus (6.2%) ‘strongly disagreed’ with this statement, and none of female students in England did.

Figure 6.14 Female students' responses in percentages on the variable "my parents think is not very important to do well in mathematics"

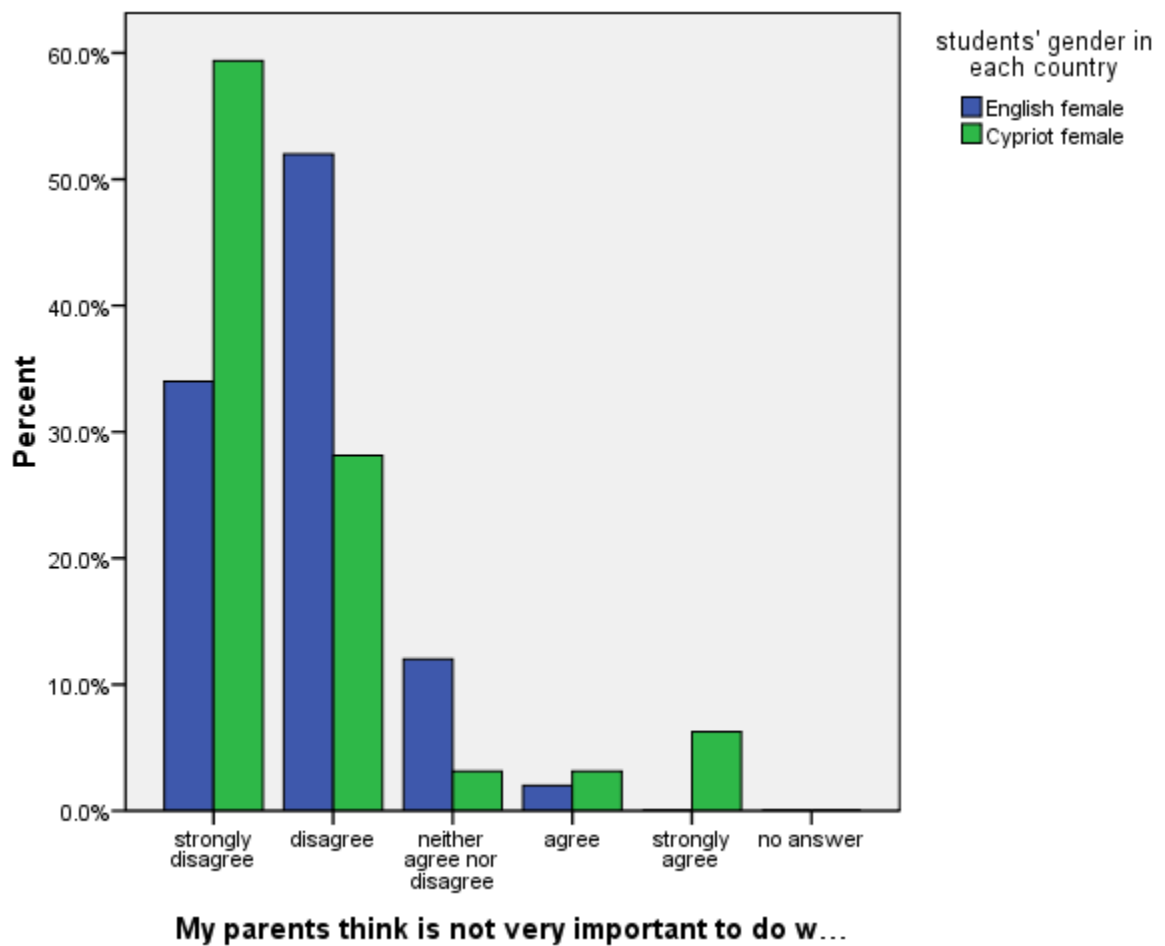


Table 6.14 My parents think is not very important to do well in mathematics

		English female	Cypriot female
Valid	Strongly disagree	34.0	59.4
Percent	Disagree	52.0	28.1
	Neither agree nor disagree	12.0	3.1
	Agree	2.0	3.1
	Strongly agree	0	6.2
	No answer	0	0
	Total	100.0	100.0

It is clear again from Figure 6.4 and Table 6.14 that more female students in Cyprus (87.5%) than female students in England (86%) disagreed with the statement “my parents think is not very important to do well in mathematics”. Although one might think that these percentages are marginally different, when looking at the ‘strongly disagree’ responses of the female students in Cyprus (59.4%) and the female students in England (34.0%) then the difference becomes more clear. It should be noted, however, that at the same time some female students in Cyprus (6.2%) ‘strongly agreed’ with this statement and none of the female students in England did. In addition, more female students in England (12%) than female students in Cyprus (3.1%) were neutral with this statement. It worth mentioning also that a small percentage of female students in Cyprus (6.2%) ‘strongly agreed’ with this statement, and none of the female students in England did.

Figure 6.5 Female students' responses in percentages on the variable "my parents expect me to do well in mathematics"

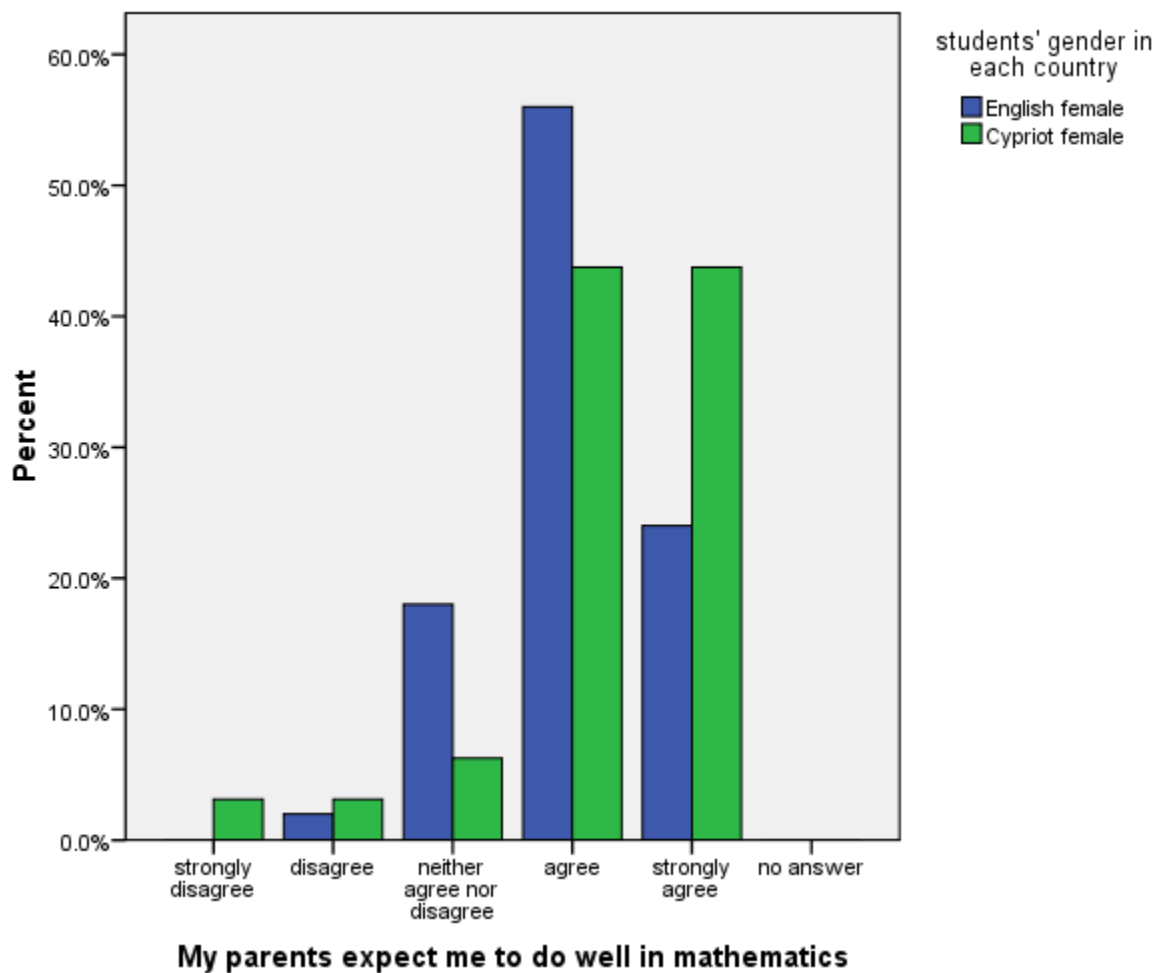


Table 6.15 My parents expect me to do well in mathematics

		English female	Cypriot female
Valid	Strongly disagree	0	3.1
Percent	Disagree	2.0	3.1
	Neither agree nor disagree	18.0	6.2
	Agree	56.0	43.8
	Strongly agree	24.0	43.8
	No answer	0	0
	Total	100.0	100.0

Once again from Figure 6.5 and Table 6.15 we can see that more female students in Cyprus (87.6%) than female students in England (80%) agreed that their parents expected them to do well in mathematics. What is interesting, however, is that the percentage of female students in Cyprus (43.8%) who 'strongly agreed' with this statement was a lot higher than the percentage of female students in England (24%) who also 'strongly agree' with it. In addition, more female students in England (18%) than female students in Cyprus (6.2%) were neutral with this statement. Moreover, a small percentage of female students in Cyprus (3.1%) 'strongly disagreed' with this statement, and none of the female students in England did.

Figure 6.6 Female students' responses in percentages on the variable "My parents think I will need maths for my future career"

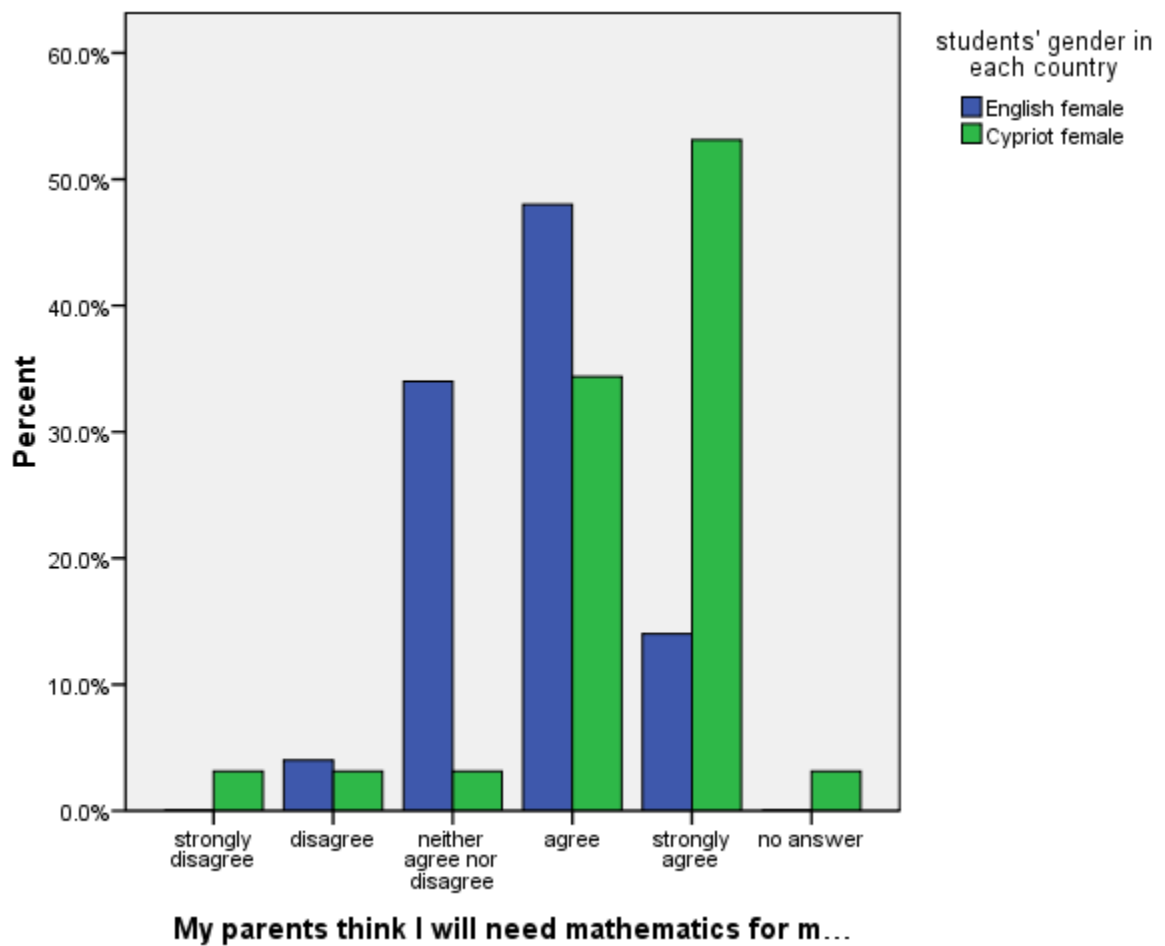


Table 6.16 My parents think I will need maths for my future career

		English female	Cypriot female
Valid	Strongly disagree	0	3.1
Percent	Disagree	4.0	3.1
	Neither agree nor disagree	34.0	3.1
	Agree	48.0	34.4
	Strongly agree	14.0	53.1
	No answer	0	3.1
	Total	100.0	100.0

As illustrated in both Figure 6.6 and Table 6.16, more female students in Cyprus (87.5%) than female students in England (62%) agreed that their parents think that they will need mathematics for their future career. Once again the percentage of the female students in Cyprus (53.1%) who 'strongly agreed' with this statement was a lot higher than the percentage of the female students in England (14.0%) who also 'strongly agreed' with it. In addition, more female students in England (34%) than female students in Cyprus (3.1%) were neutral with this statement. It is worth mentioning that a small percentage of the female students in Cyprus (3.1%) also 'strongly disagreed' with this statement, and none of the female students in England did.

Figure 6.7 Female students' responses in percentages on the variable "my parents have been always interested in my progress in maths"

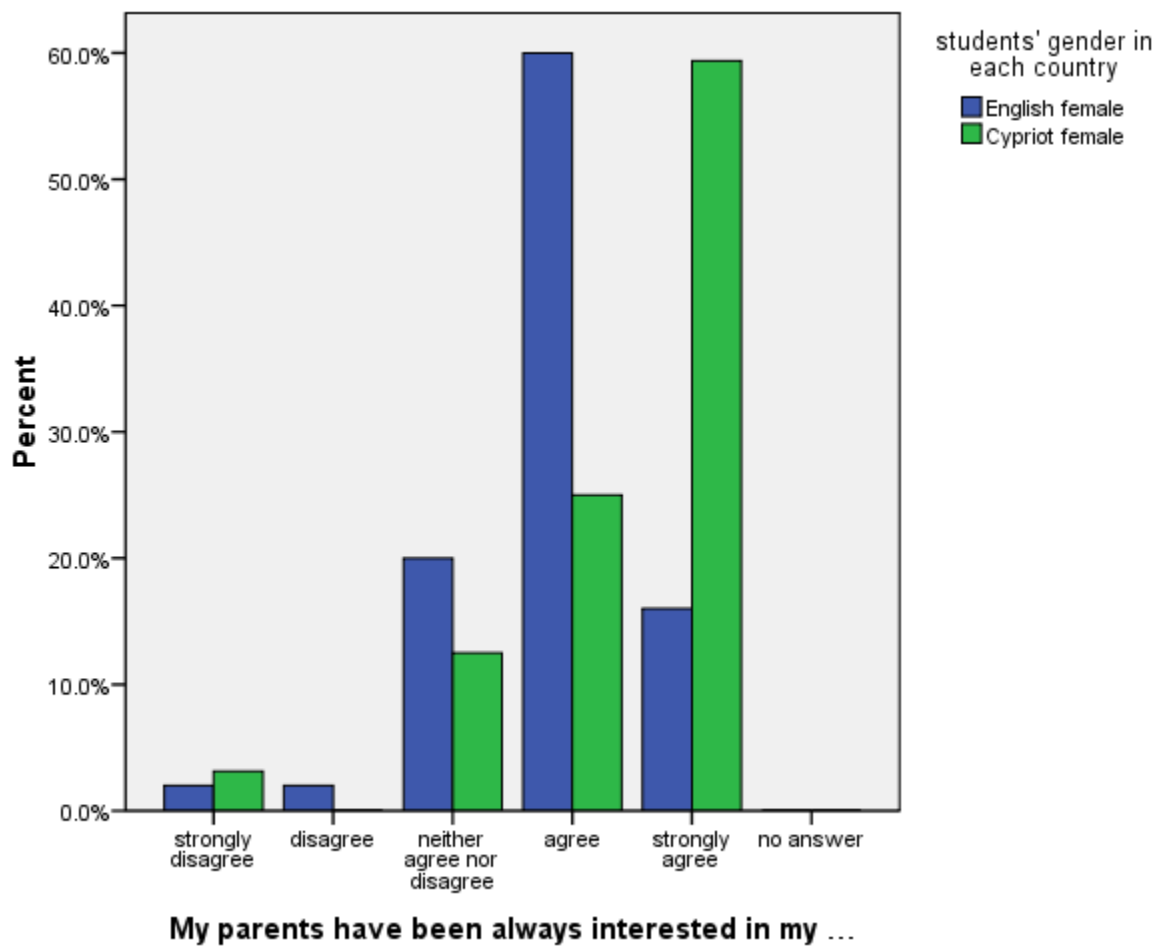


Table 6.17 My parents have been always interested in my progress in maths

		English female	Cypriot female
Valid	Strongly disagree	2.0	3.1
Percent	Disagree	2.0	0
	Neither agree nor disagree	20.0	12.5
	Agree	60.0	25.0
	Strongly agree	16.0	59.4
	No answer	0	0
	Total	100.0	100.0

Finally, looking at Figure 6.7 and Table 6.18, more female students in Cyprus (84.4%) than female students in England (76%) agreed that their parents have been always interested in their progress in mathematics. It is interesting again that the percentage of the female students in Cyprus (59.4%) who 'strongly agreed' with this statement was higher than the percentage of female students in England (16%) who also 'strongly agreed'. Moreover, more female students in England (20%) than female students in Cyprus (12.5%) were neutral with this statement.

6.3 Summary of key points

In this chapter, I reported on the different statistical stages that I followed in order to analyse the data collected from the questionnaires. The statistical analysis revealed statistically significant differences between male and female students' perceptions of mathematics as a male domain within the two countries, and statistically significant differences between female students in Cyprus and female students in England, and female students in England and male students in Cyprus regarding their perceptions of their parents' expectations regarding mathematics. Because this study aimed to compare male and female students within countries and students of the same gender between countries, I focused my attention particularly on findings about these gender groups. In addition, although four of the attitudinal factors did not reveal any statistically significant differences between any of the gender groups, I examined students' mean scores for the statements that formed each attitudinal factor and made

comparisons in order to get a better understanding of the data. Moreover, in order to elucidate further the statistically significant findings in “students’ perceptions of mathematics as a male domain” and in “students’ perceptions of their parents’ expectations with regards to mathematics” I illustrated students’ responses in percentages using graphs and tables.

When comparing students’ mean scores for the attitudinal factor “Students’ enjoyment of mathematics”, although they were marginally different between any of the gender groups, there were some noticeable and interesting trends. Specifically, the mean scores for female students in England and female students in Cyprus regarding the statement “I would like to use mathematics at university” showed that female students in England were neutral, whereas female students in Cyprus agreed with it. It seems that female students in Cyprus felt more strongly about using mathematics at university compared to the female students in England. In addition, male students in Cyprus and England agreed with the statement “I like mathematics”, whereas female students in each country tended to ‘agree’ with it. This suggests that male students in Cyprus and England felt more strongly about liking mathematics than female students in Cyprus and England.

A statistically significant difference that was found in “students’ perceptions of their parents’ expectations with regards to mathematics” between male students in Cyprus and female students in England, and between female students in

Cyprus and female students in England was confirmed first by comparing the mean scores for students in each country. A noticeable significant difference between male students in Cyprus and female students in England was regarding the statement “My parents think mathematics will help me get a good job”. Male students in Cyprus tended to ‘strongly agree’, whereas female students in England tended to ‘agree’ with it. It should be noted that female students in Cyprus also tended to ‘strongly agree’ with this statement. Another noticeable significant difference was between female students in Cyprus and female students in England regarding the statement “My parents think mathematics will help me with my future career”. Female students in Cyprus tended to ‘strongly agree’, whereas female students in England tended to ‘agree’ with this statement. This was also confirmed by looking at students’ responses in percentages: 53.1% of female students in Cyprus and only 14% of female students in England ‘strongly agreed’, and 34.4% of female students in Cyprus and 48% of female students in England ‘agreed’ with it. Moreover, according to the mean scores regarding the statement “My parents have been always interested in my progress in mathematics” female students in Cyprus tended to ‘strongly agree’, whereas female students in England tended to ‘agree’ with it. This was confirmed by looking at students’ responses in percentages. 59.4% of female students in Cyprus and only 16% of female students in England ‘strongly agreed’, and 25% of female students in Cyprus and 60% of female students in England ‘agreed’ with this statement. To sum up, there are some interesting cultural differences suggesting that female students in Cyprus felt more strongly

about their parents' expectations regarding mathematics than female students in England. In addition, it seems that there weren't any significant differences between male and female students in Cyprus regarding their perceptions of their parents' expectations, and the same applied between male and female students in England.

Although "students' perceptions of their mathematics teacher's expectations" did not reveal any statistically significant differences between male and female students within countries or between students of the same gender between the two countries, when looking at students' mean scores for each of the statements that formed this attitudinal factor some interesting trends were evident. For example, regarding the statement "My mathematics teacher thinks mathematics will help me get a good job" male and female students in Cyprus tended to 'strongly agree', whereas male and female students in England tended to 'agree' with it. It also seems that female students in England felt less strong about this statement compared to the other students. Moreover, regarding the statement "My mathematics teacher believes in my mathematical abilities" male and female students in Cyprus agreed, whereas male and female students in England tended to agree with it.

Another statistically significant difference was found in students' perceptions of mathematics as a male domain between male and female students within countries. The mean scores for the statement "Female students are as good as

male students when solving a maths problem” revealed that both female students in England and Cyprus tended to ‘strongly agree’ with this statement, whereas both male students in England and Cyprus were neutral with it. Students’ responses in percentages partly confirmed this. For example, 48% of female students in England and 56.2% of female students in Cyprus strongly agreed with this statement, whereas 36% of male students in England and 23.3% of male students in Cyprus were neutral with it. It should be noted, however, that another 24% of male students in England and 23.3% of male students in Cyprus agreed with this statement. Moreover, regarding the statement “Male students are better at maths than female students” both male students in England and male students in Cyprus tend to ‘agree’, whereas female students in England ‘disagree’ and female students in Cyprus ‘strongly disagree’ with it. Students’ responses in percentages confirmed this. For example, 36% of male students in England and 33.3% of male students in Cyprus were neutral, and another 22% of male students in England and 30% of male students in Cyprus agreed with the statement “male students are better at maths than female students”. On the other hand, 26% of female students in England and 12.5% of female students in Cyprus agreed, and another 44% of female students in England and 65.6% of female students in Cyprus strongly disagreed with this statement. This suggests that female students in Cyprus had a less stereotypical view of mathematical ability compared to female students in England, whereas male students in Cyprus had a stronger stereotypical view of mathematical ability compared to male students in England.

Although no statistically significant differences were found in “Students’ negative perceptions of their mathematics teacher’s expectations with regards to mathematics”, the mean scores of students’ responses regarding the statements that formed this attitudinal factor showed some interesting trends. Regarding the statement “My mathematics teacher thinks I will not need mathematics in my future career” male and female students in Cyprus tended to ‘strongly disagree’, and male and female students in England ‘disagreed’ with it. The mean scores suggest that the students in Cyprus perceived their mathematics teacher to think that mathematics is important for their future career more strongly than the students in England did. As I discussed earlier female students in England, also felt less strong about their mathematics teacher thinking that mathematics will help them get a good job compared to the other students in England and Cyprus. These perceptions perhaps play a significant role in the career choices of female students in England.

Lastly, another attitudinal factor that did not show any statistically significant differences between any of the gender groups was “Students’ confidence in their mathematical abilities”. A trend, however, was evident regarding the statement “I am good at mathematics”. Specifically, female students in Cyprus tended to ‘strongly agree’, and male and female students in England and male students in Cyprus were only inclined to ‘agree’ with it. It should be noted, that male students in England were inclined to ‘agree’ with this statement more compared to the female students in England. In addition, it seems that female and male students

in Cyprus felt more strong with the statement “I am able to solve mathematics problems without too much difficulty” than male and female students in England did. What is more interesting is that female students in Cyprus came across as more confident in their mathematical abilities compared to the female students in England. Perhaps their confidence in their mathematical abilities can explain their less stereotypical views of mathematical ability shown earlier.

I should note that student responses in the statements that formed these attitudinal factors showed that male and female students in England more often than male and female students in Cyprus were neutral. On the other hand, male and female students in Cyprus more often than male and female students in England tended to ‘strongly agree’ with many of the statements that formed the attitudinal factors. The reason for this could be that students in England are traditionally more moderate compared to students in Cyprus. Therefore, one should be careful before generalizing the assumptions made earlier. The analysis of the interview data that follows will shed further light on these findings.

CHAPTER 7

Findings from Qualitative Analysis

7.1 Outline of Chapter 7

In this chapter, I report on the findings of analysis of data collected through a semi-structured interview (Appendix 5C). The interview was conducted with students in Cyprus and England and consisted of 15 questions that were examining: students' perceptions of the relevance of mathematics in their life now and in the future; students' enjoyment of mathematics; students' feelings of anxiety; students' attributions of success or failure in mathematics; students' confidence in their mathematical abilities; students' motivation; students' perceptions of their parents' motivation and expectations with regards to mathematics; students' perceptions of their mathematics teacher's motivation and expectations; and students' perceptions of mathematics as a male domain. My objectives for carrying out this analysis are: to confirm and validate the findings of analysis of data collected from the questionnaires using a subsample of the respondents; to give a further insight to the findings of the questionnaire data; to allow the respondents to describe their mathematics learning experiences in Cyprus and in England and compare how these experiences might be different within each culture; and to explore the possible influencing factors that contribute to students' attitudes towards mathematics in each country.

7.2 Data analysis of the interview data

Interviews were conducted with students in Cyprus in the second week of September 2009, and with students in England during the first week of December 2009. In Cyprus I interviewed five girls and six boys who were in their final year of Lyceum (upper secondary school) doing advanced mathematics, and in England I interviewed three girls and five boys doing A-level mathematics and four girls and four boys doing further advanced level mathematics at the college under study. The interviews were audio taped for analysis and transcribed immediately after I conducted them from each country. The Greek interview transcripts were translated into English, and an independent translator was asked to confirm whether they were translated correctly. Each interview transcript was then read many times to gain a holistic picture of each interview and its main points were noted on a summary sheet.

Texts from students' interview transcripts were analysed using a First Cycle coding method which Saldaña (2009) calls "Themeing the data". This method requires a comparable reflection on participant meanings and outcomes, and involves analysis of portions of data from each interview transcript with an extended thematic statement rather than a shorter code. Therefore, each text unit of every transcript was read again before it was coded to one or more themes. It should be noted that the definition of a theme adopted in this study is the one proposed by Saldaña (2009): "a theme is a *phrase* or *sentence* that identifies what a unit of data is *about* and/ or what it *means*" (p. 139, emphasis original). A theme may be identified at its manifest level (directly observable in

the information) or at the latent level (underlying the phenomenon) (Boyatzis, 1998). After coding all the text units, each transcript was read again and was further coded wherever relevant. I should note that the themes in the data were selected taking into account the research questions, purpose, and conceptual framework of the study, as well as the literature review (e.g. Kvale, 1996). A Second Cycle coding method followed in order to search for pattern of responses across the respondents and to reorganise and reanalyse the data coded through the First Cycle method. This allowed me to develop a smaller and more select list of themes (for example some of the themes identified in the First Cycle method were merged together in the Second Cycle method because they were conceptually similar).

In order to identify how frequent a theme was for each interviewee and across the total body of interviewees I adopted a method used by Nardi and Steward (2003). Occurrence of each theme in the 27 coded interview transcripts were recorded in an interviewee-by-theme spreadsheet. The frequency of each theme was available in the last row of the spreadsheet. By examining the spreadsheet horizontally, I could identify the codes in which each interviewee scored higher and form an idea of his/her focal points. By examining the spreadsheet vertically, I could identify the codes that featured higher frequencies across the total body of interviewees. Consequently, each theme was assigned an ordered pair (x, y) as follows: x corresponds to the number of

times the theme has been identified in the coded interview transcript, and y to the number of students who have referred to the theme.

I should note that all themes are descriptive and emerged from the data (however because the interview was designed to investigate specific attitudinal domains some of the themes overlap with these domains). The themes emerged from the data were categorised into five theme headings according to commonality, and were ordered in superordinate and subordinate outline format to reflect on their possible groupings and relationship:

I. Students' perceptions of mathematics

M1: Students have a utilitarian view of mathematics (dealing with money, fundamental to sciences, career prospects)

M2: Students perceive mathematics interesting

M3: Students enjoy mathematics because it is challenging

II. Students' motivation

Mot1: Students are motivated to do well in mathematics because they need good grades to pursue studies at university

Mot2: Students are motivated to do well in mathematics because they like mathematics

Mot3: Students are motivated to do well in mathematics for personal satisfaction

III. Students' perceptions of own ability and performance in mathematics

P1: Students perceive their abilities in mathematics as strong

P2: Students feel confident about their abilities in mathematics when they practise mathematics

P3: Students attribute good performance in mathematics to practice

P4: Students attribute good performance in mathematics to enjoyment of mathematics

P5: Students feel anxious when mathematics problems are difficult to solve

P6: Students' confidence in their abilities in mathematics depends on the difficulty of a mathematics problem

P7: Students attribute good performance in mathematics to natural ability

P8: Students attribute good performance in mathematics to mathematics teacher

IV. Perceived social influence in mathematical learning

S1: Students perceive their parents to expect them to do well in mathematics

S2: Students perceive their mathematics teacher to expect them to do well in mathematics

S3: Students express positive feelings about their mathematics teacher

S4: Students perceive their parents to encourage them in learning mathematics

S5: Students' express negative feelings about their mathematics teacher

V. Gender stereotypes

St1: Students perceive girls to be equally good as boys at mathematics

St2: Students perceive girls to be good at mathematics because they work hard

St3: Students perceive boys to be naturally good at mathematics

7.3 Findings from data analysis of the interview data

The findings from data analysis of the interview data are reported and discussed in the five theme headings with tables that illustrate frequencies of each theme by students' gender in each country. Each theme is accompanied by its (x, y) frequency ordered pair and is discussed using extracts from students' interview transcripts.

7.3.1 Students' perceptions of mathematics

Table 7.1 Frequencies of "Students' perceptions of mathematics"

Theme	Male British (n=9)	Female British (n=7)	Male Cypriot (n=6)	Female Cypriot (n=5)
Students have a utilitarian view of mathematics	(9, 9)	(7, 7)	(5, 5)	(5, 5)
Students perceive mathematics interesting	(5, 5)	(6, 6)	(4, 4)	(5, 4)
Students enjoy mathematics	(9, 7)	(5, 5)	(1, 1)	(3, 3)

because it is
challenging

According to research (e.g. Brown et al. 2008; Nardi and Steward, 2003; Williams and Ivey, 2001) perceived dislike, boredom, and lack of relevance are important reasons for students not continuing with mathematics. The students whose attitudes towards mathematics this study focuses on choose to take mathematics at advanced level. The overwhelming majority of them, 10 out of 11 students in Cyprus and 16 out of 16 students in England, perceived mathematics useful in their lives and often used words such as 'challenging' and 'interesting' to describe it.

M1: Students have a utilitarian view of mathematics (dealing with money, fundamental to sciences, career prospects) (26, 26)

In Sneha's words:

Sneha: "Because we couldn't calculate like when you buy stuff you need to know simple maths. . ." (Female Asian British)

Polina also said:

Polina: ". . . I think it [mathematics] is important in our life because you need mathematics for example to buy things or in general for your studies, your job. In architecture you will need to make measurements. Generally speaking, all jobs need mathematics." (Female Cypriot)

Similarly, Lucas said:

Lucas: “. . . it [mathematics] is important because it is used every day in our life or not as such in our every day life, but mostly it is used in sciences.” (Male Cypriot)

Bhavik also explained:

Bhavik: “Um, well on the scientific persons I am going to be bias in maths’s favour, but um it’s just generally I don’t think science and engineering could have developed if it wasn’t for mathematics. It [mathematics] is more important than English as far as I am concerned.” (Male Asian British)

Only one male student from Cyprus did not perceive mathematics taught at advanced level useful in every day life:

In Vasilis words:

Vasilis: “. . . I don’t think it [mathematics] is very useful in every day life. The mathematics that you find in every day life is quite simple.” (Male Cypriot)

Many of the students from both countries (8 students in Cyprus and 11 students in England) perceived mathematics as an interesting subject because of its process and diversity, and also because it can be applied in real life.

M2: Students perceive mathematics as an interesting subject (20, 19)

For example, Lucas found mathematics interesting because it has application in real life:

Lucas: “This year it becomes more interesting. It has more meaning. Until now I used to think that mathematics was just solving maths problems, but this year it has some meaning and we [students] may even put some of its application into practice not just solving maths problems.” (Male Cypriot)

Sam also explained that he found the problem solving aspect of mathematics interesting:

Sam: “I find it very interesting. I love all the problem solving that you have to do in maths and I think maybe that’s an obstacle to some people and or maybe some people never get to that stage. They always think of mathematics as all the calculation, which I find boring. I find that boring, but I don’t find um more advanced mathematics boring at all.” (Male British)

Eleni found mathematics interesting at advanced level because of its diversity:

Eleni: “It [mathematics] is an interesting subject, because every time we learn something new. We don’t do the same things. In advanced mathematics we do different things and learn something new every time.” (Female Cypriot)

Moreover, many of the students from both countries expressed enjoyment of mathematics because of its challenging nature. Although this view was common between the students in Cyprus (4 out of 11) and the students in England (12 out

of 16) it was more often expressed by the students in England. It should be noted that the male students in Cyprus, expressed this view less often than any of the other students. It is worth mentioning also that one male student in England highlighted his enjoyment of mathematics because of its challenging character more than once in his interview.

M3: Students enjoy mathematics because it is challenging (18, 16)

In Samia's words:

Samia: "I think that I would have liked it [pause]. I don't know, because [pause] because it's a bit hard. You enjoy it [mathematics] because it gives your brain a bit of work out. But if it was easier then I don't know. I don't think I would enjoy it if it was easier, because it wouldn't make me work hard." (Female Asian British)

Shyam also said:

Shyam: "Sometimes I find tricky some problems I come across and that [pause]. But I think that's part of it. I enjoy learning maths as well. It would be boring if every time you've got the answers right. You wouldn't feel happy, like, you have to come across problems that help you problem solve." (Male Asian British)

Miten indicated:

Miten: “. . .I like it. It’s a good challenge. I do like doing it knowing is a good challenge.” (Male Asian British)

In addition, Miten said:

Miten: “I like the challenge. That’s the main thing. I think. That’s why I like it.

Maria also said:

Maria: “. . .what is nice about mathematics is that you find it hard to solve mathematics problems and that you are puzzled.” (Female Greek-Cypriot)

Vasilis also explained:

Vasilis: “If I had to solve every mathematics problem in one minute without think it through, then it won’t be a challenge it will be boring.” (Male Greek-Cypriot)

Summary of key points

Both the students in Cyprus and the students in England perceived mathematics useful in their life and often described it as ‘interesting’ and ‘challenging’. However, when comparing the students of the same gender between the two countries and male and female students within the two countries some noticeable differences emerged from the data: more male students in England (7 out of 16) than male students in Cyprus (1 out of 6), and more female students in Cyprus (3 out of 5) than male students in Cyprus (1 out of 6) perceived mathematics

enjoyable because it is challenging. In addition, one male student in England placed emphasis on his enjoyment of mathematics because of its challenging nature more than once in his interview.

7.3.2 Students' motivation

Table 7.2 Frequencies of "Students' motivation"

Theme	Male British (n=9)	Female British (n=7)	Male Cypriot (n=6)	Female Cypriot (n=5)
Students are motivated to do well in mathematics because they need good grades to pursue studies at university	(7, 5)	(5, 3)	(10, 5)	(8, 5)
Students are motivated to do well in mathematics because they like mathematics	(6, 5)	(5, 5)	(7, 4)	(4, 4)
Students are motivated to do well in mathematics for personal satisfaction	(4, 3)	(2, 2)	(1, 1)	(2, 2)

Note: These are frequencies of those students who gave any reason for being motivated to do well in mathematics; some of them gave more than one reason.

Motivation in this study is examined as students' need and desire to participate in and be successful in mathematics. In this sense motivation is distinguished as

extrinsic (depending from the availability of external rewards) and intrinsic (arising by interest in the subject being studied) (e.g. Ryan and Deci, 2000). Evidence from the interview data suggests that both the students in Cyprus (10 out of 11) and the students in England (8 out of 16) were motivated to do well in mathematics in order to get the grades that would allow them to pursue studies at university. However, this was more often expressed by the students in Cyprus than the students in England. Noticeable differences were evident between: male (5 out of 9) and female (3 out of 7) students in England; male students in England (5 out of 9) and male students in Cyprus (5 out of 6); and female students in England (3 out of 7) and female students in Cyprus (5 out of 5). What is striking from the interview data is that many of the students emphasised twice in their interviews their desire to do well in mathematics in order to get good grades that would allow them to follow mathematics-related careers. This suggests that students were highly motivated to do well in mathematics because of their future career plans.

Mot1: Students are motivated to do well in mathematics because they need good grades to pursue studies at university (30, 18)

Anna explained why it was important for her to perform well in mathematics:

Anna: “It is very important, because I want to study it [mathematics] at university and I need to have good grades.” (Female Cypriot)

Anna also on her reasons for taking advanced mathematics said:

Anna: “Because I want to do mathematics at university level.”

Similar to Anna, Giannis said:

Giannis: “It has to be very important. I have to have a good grade in order to get a place at university where I want to.” (Male Cypriot)

Giannis also indicated when he was asked what motivates him to do well in mathematics:

Giannis: “My future career plans and to get a good grade in mathematics.”

Chintam also said:

Chintam: “Um, getting to university um and getting a good um getting into a good university which requires A grade in maths. That motivates me.” (Male Asian British)

Rima on how important was for her to do well in mathematics said:

Rima: “Very important, because I need to get a good grade to go to university.”
(Female Asian British)

Rima also on her reason for being motivated to do well in mathematics said:

Rima: “To go to do it [mathematics] at university. To be able to do it at that level.”

Many of the students in Cyprus (8 out of 11) and the students in England (10 out of 16) also expressed in their interviews their desire to do well in mathematics because they liked it. A noticeable trend emerging from the interview data is that female students in England were more often motivated to do well in mathematics because they liked the subject (5 out of 7) than to do well in it because they needed good grades to pursue mathematics-related studies at university (3 out of 7). On the other hand, female students in Cyprus more often placed emphasis on their desire to do well in mathematics in order to pursue mathematics-related studies at university (this view was expressed more than once by three out of the five female students in Cyprus who expressed this view in their interviews). This may suggest that the female students in England who participated in this study opted for advanced mathematics mainly because they liked mathematics and not because of their future career plans. However, it seemed that for the female students in Cyprus it was more important to do well in mathematics to follow a mathematics related career. It should be also noted that some of the male students in England and male students in Cyprus were highly intrinsically motivated to do well in mathematics. These students expressed their desire to do well in mathematics because they liked it more than once in their interviews (see frequencies in Table 7.2).

Mot2: Students are motivated to do well in mathematics because they like mathematics (22, 18)

In Samia's words:

Samia: "Because at GCSE I really liked it [mathematics] and then I wanted to carry on [pause]. So, I um so I like it has been one of my favourite subjects since I was young. So, I wanted to carry on with it at A-level." (Female Asian British)

Eleni on her reasons for taking advanced mathematics said:

Eleni: "I am a person of pure and applied sciences. I like mathematics."
(Female Cypriot)

Andreas when asked what motivated him to do well in mathematics said:

Andreas: "There are many motives. Of course is to get a good grade, but also my love for mathematics. I like mathematics." (Male Cypriot)

Likewise, Chintam said:

Chintam: "Um, I've always liked maths and it's been one of my favourite subjects and I've been good at it since I was a little kid. So, I thought of carrying on." (Male Asian British)

Some of the students in Cyprus (2 female and 1 male student) and students in England (2 female and 3 male students) also expressed their desire to do well in mathematics for personal satisfaction. These students perceived mathematics as highly rewarding. A noticeable difference was that more male students in

England (3 out of nine) than male students in Cyprus (1 out of 6) expressed this view.

Mot3: Students are motivated to do well in mathematics for personal satisfaction (9, 8)

In Eleni's words:

Eleni: "I do it to please myself. Being good at mathematics means that I will get a place at university, I will get the place that I want. But if I neglect it [mathematics] and say "I don't care" then I will not gain anything me or anybody else." (Female Cypriot)

Vasilis said:

Vasilis: ". . . but I also feel good when I do well in a subject that I like, that it is difficult and I have to exercise my mind. I feel good with myself." (Male Cypriot)

Samia explained:

Samia: "I think out of the three subjects that I do, I like maths more. But because I have like maths checked out I need to spend more time on it and then I can't actually spend as much time as I would actually like to do on maths. So I think that I might have B, I might be a B grader, you know, or minus but personally I would want to get A because I enjoy maths so much and I would like that to be reflected in my grade." (Female Asian British)

Shyam also said:

Shyam: “Um, just that I do such a hard subject and doing well in the subject you know it’s you are rewarded as well. If this person can do this and it’s regarded highly everywhere, so if you do well in it then looks good on you.”

(Male Asian British)

Summary of key points

Many of the students in Cyprus and England (18 out of 27) expressed the need to do well in mathematics to get good grades that would allow them to pursue studies at university. Students from both countries (18 out of 27) also expressed their desire to do well in mathematics because they like it, and for personal satisfaction (8 out of 27 students). The interview data suggests that male and female students in Cyprus (10 out of 11) more often than male and female students in England (8 out of 16) expressed the need to do well in mathematics to get good grades that would allow them to pursue studies at university. It should be noted though that many of the students from both countries emphasised more than once in their interviews their desire to do well in mathematics because of their future career plans. On the other hand, it seemed from the interview data that students in England (10 out of 16) were more often motivated to do well in mathematics because they liked mathematics. In addition, some of the male students from both countries were highly intrinsically motivated. A trend emerging from the interview data suggests that female students in Cyprus were motivated to do well in mathematics mainly because of their future

career plans, but also because they liked mathematics, whereas female students in England were motivated to do well in mathematics mainly because they liked mathematics. This cultural difference between female students in Cyprus and female students in England could possibly explain differences between them in terms of career choices. Another noticeable difference was that more male students in England (3 out of 9) than male students in Cyprus (1 out of 6) expressed their desire to do well in mathematics for personal satisfaction. It is worth noting that those students who expressed their desire to do well in mathematics for personal satisfaction perceived mathematics as highly rewarding.

7.3.3 Students' perceptions of own ability and performance in mathematics

Table 7.3 Frequencies of "Students' perceptions of own ability and performance in mathematics"

Theme	Male British (n=9)	Female British (n=7)	Male Cypriot (n=6)	Female Cypriot (n=5)
Students perceive their abilities in mathematics as strong	(7, 6)	(5, 4)	(2, 2)	(3, 2)
Students feel confident about their abilities in mathematics when they practise mathematics	(4, 4)	(2, 2)	(4, 4)	(4, 2)
Students attribute good	(2, 2)	(2, 2)	(2, 2)	(3, 3)

performance in mathematics to practice				
Students attribute good performance in mathematics to enjoyment of mathematics	(3, 3)	(2, 2)	(1, 1)	(1, 1)
Students feel anxious when mathematics problems are difficult to solve	(2, 2)	(2, 2)	(1, 1)	(2, 2)
Students' confidence in their abilities in mathematics depends on the difficulty of a mathematics problem	(1, 1)	(2, 2)	(2, 2)	(1, 1)
Students attribute good performance in mathematics to natural ability	(0, 0)	(2, 2)	(2, 2)	(0, 0)
Students attribute good performance in mathematics	(0, 0)	(1, 1)	(2, 1)	(1, 1)

to
mathematics
teacher

Students' confidence in their mathematical abilities has often been associated with students' participation in mathematics course taking and career aspirations in mathematics-related fields (e.g. Meyer and Koehler, 1990; Burton, 2001; Ireson, Hallam and Plewis, 2001). The self-images of mathematical ability of both students in Cyprus (4 out of 11) and students in England (10 out of 16) who participated in this study were mainly positive. An evident trend in the interview data was that female students in England (4 out of 7) more often than female students in Cyprus (2 out of 5) expressed confidence in their abilities in mathematics. The same trend was evident between male students in England (6 out of 9) and male students in Cyprus (2 out of 6). It is worth mentioning that two of the students in England (one male and one female student) and one female student in Cyprus expressed more than once in their interviews that they perceived their abilities in mathematics as strong, which suggests that they were highly confident in their mathematical abilities.

P1: Students perceive their abilities in mathematics as strong (17, 14)

When Kavita was asked how confident she felt about her abilities in mathematics, she declared:

Kavita: "Um, I would say I am quite confident." (Female Asian British)

Rina also said:

Rina: “I am more confident in maths than in any other subject.” (Female Asian British)

Bhavik explained that he felt confident because of his grade in mathematics:

Bhavik: “I am fairly confident. Um after having got an A-level grade A in one year I know that I am at A-grade ability when I solve problems. So, I have that confidence enriched before the exam; I deliberately know what grade I was on. So, I have more confidence now. I am not overconfident I don’t think that I can solve any problem that comes my way, but I do [pause] I am confident that normally I could solve the problem.” (Male Asian British)

Sam expressed more confidence in his abilities in mathematics than in his abilities in physics:

Sam: “Um, I would say is one of the easiest subjects for me. I can do it quite easily. But then you know there are some things that are quite tricky. But in general it’s just very enjoyable and I can do it without too much effort. Um whereas subjects like physics is [laughs] I find a lot more difficult but not as enjoyable really.” (Male British)

Polina also compared her level of ease or difficulty in mathematics to other subjects:

Polina: “I regard it [mathematics] as an easier subject in comparison to other

subjects. I prefer mathematics.” (Female Cypriot)

In addition, Polina said in her interview:

Polina: “I don’t have any difficulty in mathematics. This subject is not difficult for me.” (Female Cypriot)

When Anna was asked whether she was able to solve mathematics problems without too much difficulty, said:

Anna: “Yes, because mathematics is straightforward.” (Female Cypriot)

Similarly, Lucas said:

Lucas: “Yes, I think that yes [solve mathematics problems without too much difficulty]. Sometimes though I can do it very well. But most of the time I think that I can solve mathematics problems.

Giorgos perceived himself as one of the brains in his classroom:

Giorgos: “I think in quotation marks that I am one of the brains in my classroom. I like the subject [mathematics], I have a good time with my mathematics teacher, I am someone who often solves mathematics problems on the blackboard and who helps his peers; therefore I don’t have any problem.” (Male Cypriot)

The interview data suggests that students in Cyprus (6 out of 11) and students in England (6 out of 16) often felt confident in their abilities in mathematics when they practised mathematics. A trend that emerged from the interview data was that male students in England (4 out of 9) more often than female students in England (2 out of 5) expressed this view and the same applied for the male (4 out of 6) and the female (2 out of 5) students in Cyprus. It is worth noting that the two female students in Cyprus in particular placed more emphasis in their interviews about feeling confident in their mathematical abilities when practised mathematics (see frequencies in Table 7.3).

P2: Students feel confident about their abilities in mathematics when they practise mathematics (14, 12)

In Miten's words:

Miten: "Um, fairly confident because I practise. So, yeah that's why I am confident. Because I practise, I make time for it [mathematics] and make sure that I don't skip anything, and I make sure I understand it thoroughly before I move to a different thing." (Male Asian British)

Samia also explained:

Samia: "Um, if I know it [mathematics problem] like properly, then I can do it. But then sometimes I have to backup my past work to see what I have done. Sometimes I can't just do it like of by heart. I have to like look at past work and

then see how I did at that exam point; then I can do it really easy. (Female Asian British)

Similar to the others, Maria said:

Maria: “Generally speaking it [mathematics] is an easy subject but if you don’t practise it; it will seem to you as quite difficult.” (Female Cypriot)

Andreas also indicated:

Andreas: “It depends on the practice you do. There are some parts in mathematics that are difficult, but with practice you see them from a different point of view.” (Male Cypriot)

A small number of students in Cyprus (3 out of 11) and students in England (3 out of 16) felt less confident in their abilities in mathematics when mathematics was difficult.

P6: Students’ confidence in their abilities in mathematics depends on the difficulty of a mathematics problem (6, 6)

In Eleni’s words:

Eleni: “When I solve a mathematics problem and I see that something is going wrong and I don’t understand it, I mean I don’t understand the instructions either then I realise I have difficulties. However, when I understand them

[mathematics problems] and I see that I can solve mathematics problems and I can solve them correctly then it means that I don't have some kind of problem.” (Female Cypriot).

Giorgos also indicated:

Giorgos: “When there are mathematics chapters that are very easy for me, I don't find it difficult to solve anything and I feel confident.” (Male Cypriot)

Samia explained:

Samia: “I think that [pause]. I don't think I am good at maths, but I think I am like average. I don't think I am bad at maths, but I think I get a good grasp of it. But then you know the harder question I don't understand that well. So it takes me longer to work out the question.” (Female Asian British)

Shyam also said:

Shyam: “Um, certain parts of it [mathematics] are like [pause]. At an early age I found it really too easy. When I am doing advanced mathematics it's, I've seen that is quite a few challenging parts from math which I do find difficult.” (Male Asian British)

Lack of confidence in students' ability to do mathematics has been associated in the literature with anxiety (e.g. Garry, 2005). As it has already demonstrated using extracts from students' interview transcripts, most of the students (16 out of

27) who participated in this study often felt strong in their abilities in mathematics and many of them (12 out of 27) often felt confident when practising mathematics. Therefore, it was not surprising that the overwhelming majority of the students (20 out of 27) in Cyprus and England did not express feelings of anxiety when solving mathematics problems in their interviews.

In Shahzan's words:

Shahzan: "Not at all. Not at all. I feel comfortable doing it." (Male Asian British)

Maria also said:

Maria: "No, not at all [laughs]. On the contrary, I relax when I solve them [mathematics problems]." (Female Cypriot)

However, a small number of students in Cyprus (3 out of 11) and students in England (4 out of 16) indicated in their interviews that they felt anxious when mathematics problems were difficult to solve.

P5: Students feel anxious when mathematics problems are difficult to solve
(7, 7)

In Emilia's words:

Emilia: "Yeah, sometimes I do get a bit stressed when I don't know how to solve it [mathematics problem]. When there is always a way around it, it means

that, when you do actually find the right answer then I feel a bit all relieved and cheery. It's good feeling when you know the answer, when you work it out."

(Female British)

Joe said:

Joe: "Um if I get them [mathematics problems] wrong, yes. But the problem solving I don't know is the bit that I enjoy is the sort of competitive um more [pause]. The problem solving thing that I actually like, like having to think rather than using um [pause]. Yes the problem solving bit is good, but it can be stressful if you can't get it, can't get the answer." (Male British)

Likewise, Irene said in her interview:

Irene: "Basically sometimes yes. Let's say when a mathematics problem is difficult and you spend a lot of time looking at it, and you realise that you can't do it you stress out and you feel a little bit of disappointment. I feel anxious mostly when I am uncertain during mathematics tests, when I don't understand something well and I need to do it again then I stress out but then I need to release my stress in order to perform well." (Female Cypriot)

Vasilis also said:

Vasilis: "Sometimes, when I don't study enough I feel a bit stressed of what I am going to write [in a test]. It [mathematics] is not an easy subject." (Male Cypriot)

Many studies (e.g. Bar-Tal, 2000; Eccles et al. 1986; Lloyd, Walsh, and Yailagh 2005; Nenty, 1998) have found small, but consistent gender differences in the way students attribute causation for success or failure in mathematics. Boys more often than girls attribute their successes in mathematics to task difficulty or ability (these are considered as stable factors according to Weiner's theory-see literature review for more details), whereas girls attribute their successes in mathematics to effort, luck, and good teacher (which are considered as unstable factors according to Weiner's theory). The most common attribution for good performance in mathematics expressed by the students in Cyprus (5 out of 11) and students in England (4 out of 16) was practice.

P3: Students attribute good performance in mathematics to practice (9, 9)

In Irene words:

Irene: "I have noticed that I perform well when I study well. For example, I solve mathematics problems not only from my school's mathematics book but from other books with mathematics exercises and I see my progress from my mathematics tests. But when I say "Uh, this mathematics problem is boring and I am not doing it" and I start reading a chapter and I choose to do only some of the mathematics exercises, then at the end of a mathematics test I am able to see where I am lacking in to see the correct way to solve mathematics problem and then I understand [how to do it]." (Female Cypriot)

Rafael also said:

Rafael: "First and mostly is how well I understood it [mathematics] and how well I comprehended it and secondly how well I have prepared my self for the test."

(Male Cypriot)

Yasmeen also indicated:

Yasmeen: "I think I do well because I do a lot of practice, example questions and um." (Female Asian British)

Emilia said:

Emilia: "Um, well I am doing all right now. I think it's just because [pause]. I think in maths you just need to work hard and do lots of work put lots of work in. As long as you do a lot of work, then you can do well in maths. It's not like natural ability with me. Like maybe for you know PhD level is something that you need to be naturally good at, but right now I think as long as you do a lot of work then you get a good grade at the end. Yeah." (Female British)

Similar to the others, Shahzan said:

Shahzan: "I think I do well because um my first exam I didn't do really well but then I picked my um my effort up next time, working a lot harder and working at it. And that's what it took, just a bit of hard work and I've got it." (Male Asian British)

Some of the students in Cyprus (2 out of 11) and students in England (5 out of 16) attributed good performance in mathematics to their enjoyment of mathematics. This was expressed mainly by the students in England.

P4: Students attribute good performance in mathematics to enjoyment of mathematics (7, 7)

In Kavita's words:

Kavita: "Um, I am not sure. I think it's just since I was little I was quite into it [mathematics]. So, I learnt time tables early and everything. So, I just enjoyed it." (Female Asian British)

Sam also explained:

Sam: "Um, I am not sure. I am not sure really. I suppose I really like the problem solving aspect and I am quite good at that, at being able to look at a problem and tell what to do with it. Um, however, I was never good at maths when I was younger because I could never see the point in learning time tables and . . . to the state of not knowing them. So, um you know I struggled early on because I couldn't see where it was all going. But I think once I hit GCSE or even A-levels at Stats [Statistics] I managed to really understand what it was all about. It wasn't about adding numbers up." (Male British)

Shyam attributed his good performance in mathematics both to practice and his enjoyment of mathematics:

Shyam: “I think is because I spend a lot of time working on it outside the college as well. And just generally I’ve always had a passion for maths. If you like the subject you will always going to do well in it.” (Male Asian British)

Maria also said:

Maria: “Because I am interested in mathematics. If I didn’t like it [mathematics] I wouldn’t perform well, but because I like it I perform well.”

Vasilis explained:

Vasilis: “It is a matter of determination and whether you like mathematics or not. As I said earlier, mathematics is a subject for those who like the challenge of a mathematics problem. You have to have determination. It is not only about studying you need to have some knowledge of the mathematical formulas, but also the desire to put them into practice.” (Male Cypriot)

A very small number of students in Cyprus and England (5 out of 27) attributed good performance in mathematics to natural ability. This was particularly expressed by male students in Cyprus (3 out of 6) and two female students in England (2 out of 7). None of the male students in England and none of the female students in Cyprus attributed good performance in mathematics to natural ability. Students in England are traditionally more moderate in comparison to

students in Cyprus. Therefore, it is reasonable that none of the male students in England (and particularly the two English male participants Sam and Joe) perceived themselves as naturally good at mathematics. It should be also noted that the two female students in England who perceived themselves as naturally good at mathematics were Asian British.

P7: Students attribute good performance in mathematics to natural ability
(5, 5)

In Lucas' words:

Lucas: "I think for some [people] it [performing well] is natural ability, for some others it is because they study, and for others it is because they attend private lessons [tuition]. I think for me it is natural ability. I don't study a lot, but I think I am naturally good at it." (Male Cypriot)

Andreas attributed his performance in mathematics to both natural ability and hard work:

Andreas: "It's a combination of factors; because of my natural ability and also because of a lot of hard work." (Male Cypriot)

Sneha also declared:

Sneha: "Um, I think I've got a scientific brain so. I am not very good at English and stuff, but I am good at science and maths." (Female Asian British)

Rina also perceived her good performance in mathematics as innate:

Rina: “Um, I think it runs in the family [laughs]. Some are very good at it [mathematics], so it’s passed on.” (Female Asian British)

A small number of students in Cyprus and England (3 out of 27) highlighted in their accounts the importance of a good teacher (i.e. a teacher who has good ways of teaching and helps students) for their performance in mathematics. Mainly the students in Cyprus (2 out of 11) and only one female student in England (1 out of 16) attributed good performance in mathematics to their mathematics teacher.

P8: Students attribute good performance in mathematics to mathematics teacher (4, 3)

In Eleni’s words:

Eleni: “It depends on the mathematics teacher. It is not only to be a good student, it depends on the way she [mathematics teacher] transmits her knowledge to you. If she explains it well, and shows you that she is interested on how you as a person will do [in mathematics] then you will understand it and every time you don’t understand something you will ask her and she will explain it to you even though you have asked her the same thing before. So it depends mostly on the mathematics teacher.” (Female Cypriot)

Giorgos also explained:

Giorgos: “I said earlier that at the beginning [of secondary school] I was not good at mathematics. I believe that after a lot of studying and after I had different mathematics teachers and attended private lessons [tuition], I understand what my mathematics teacher says and if I don’t understand something I ask her [mathematics teacher]. I try not to learn it by repeating every mathematics theory like a parrot [parrot work] and therefore I don’t have any difficulty.” (Male Cypriot)

Samia also indicated:

Samia: “. . .um the teachers the way they teach maths as well, that’s why I am good.” (Female Asian British)

Summary of key points

Many of the students in Cyprus and England (14 out of 27) perceived their abilities in mathematics as strong. However, female students in Cyprus (2 out of 5) perceived their abilities in mathematics as strong less often than female students in England (4 out of 7). The same trend was evident between male students in Cyprus (2 out of 6) and male students in England (6 out of 9). In addition, it seemed that students from both countries (12 out of 27) often felt confident in their abilities in mathematics when they practised mathematics. This view was mainly expressed by male students in Cyprus (4 out of 6) and male students in England (4 out of 9) than female students in Cyprus (2 out of 5) and

female students in England (2 out of 7). It is worth mentioning that the two female students in Cyprus particularly stressed in their interviews their confidence in their abilities in mathematics when practised mathematics. Moreover, some of the students in Cyprus (3 out of 27) and some of the students in England (3 out of 16) felt that their confidence in their abilities in mathematics depended on the difficulty of a mathematics problem. This was expressed more often by male students in Cyprus (2 out of 6) and female students in England (2 out of 7). Furthermore, the interview data suggest that the overwhelming majority of students in Cyprus and England (20 out of 27) did not feel anxious when solving mathematics problems. Feelings of anxiety when solving difficult mathematics problems were expressed only by 3 students in Cyprus (3 out of 11) and 4 students in England (4 out of 16). This was not surprising since many of the students in Cyprus and England often had a positive self-image of their mathematical ability.

The interview data also suggest some differences in the attribution patterns of students in Cyprus and England for their performance in mathematics. The most common attribution for good performance in mathematics expressed by the students in Cyprus and England (9 out of 27) was practice. Female students in Cyprus (3 out of 5) attributed good performance in mathematics to practice more often than male students in Cyprus (2 out of 6) and female students in England (2 out of 7). Students in Cyprus and England (7 out of 27) also attributed good performance in mathematics to enjoyment of mathematics; this was more often

expressed by the students in England (5 out of 16). A small number of students in Cyprus and England (5 out of 27) attributed success in mathematics to natural ability. This was only expressed by male students in Cyprus (3 out of 6) and female students in England (2 out of 7). Lastly, a very small number of students in Cyprus and England (4 out of 27) attributed good performance in mathematics to the mathematics teacher. This was only expressed by one female student in England, and one female and one male student in Cyprus.

7.3.4 Perceived social influence in mathematical learning

Table 7.4 Frequencies of “Perceived social influence in mathematical learning”

Theme	Male British (n=9)	Female British (n=7)	Male Cypriot (n=6)	Female Cypriot (n=5)
Students perceive their parents to expect them to do well in mathematics	(8, 8)	(6, 6)	(6, 6)	(5, 5)
Students perceive their mathematics teacher to expect them to do well in mathematics	(9, 9)	(7, 7)	(5, 5)	(4, 4)
Students express positive feelings about their mathematics teacher	(6, 6)	(4, 4)	(1, 1)	(3, 3)

Students perceive their parents to encourage them in learning mathematics	(4, 4)	(3, 3)	(3, 3)	(2, 2)
Students express negative feelings about their mathematics teacher	(2, 2)	(1, 1)	(4, 3)	(3, 2)

Parental influence, such as parental encouragement, parental expectation, and parents' attitudes towards mathematics, has been identified in the literature as having a significant impact on students' attitudes towards mathematics (e.g. Catsambis & Suazo-Garcia, 1999; Ma 2001; Wang et al. 1996; Zeldin & Pajares, 2000). The overwhelming majority of the students (25 out of 27) involved in this study perceived their parents to expect them to do well in mathematics. Some of the students were more explicit about the reasons their parents expected them to do well in mathematics. For example, students indicated that their parents perceived mathematics as an important subject, or they were aware of students' abilities in mathematics and their aspirations to follow studies in mathematics related fields, and therefore wanted them to do well in it.

S1: Students perceive their parents to expect them to do well in mathematics
(25, 25)

In Yasmeen's words:

Yasmeen: "Yeah, they do. They think of it [mathematics] as an important subject, so they expect me to do well in it." (Female Asian British)

Abhilash also indicated:

Abhilash: "Yeah, they want me to do really well because they know I can and they expect me to." (Male Asian British)

Similar to the others, Anna said:

Anna: "Yes. They are pleased to know that I want to study mathematics at university and they want me to do well in it." (Female Cypriot)

Giorgos was more explicit about his parents' expectations of him with regards to mathematics:

Giorgos: "I am thinking of becoming a mathematician. My parents are aware of that and they tell me that given that I want to become something that involves this particular subject it means that I need to be exceptionally good at it. They tell me I need to study more, to have good knowledge of anything that I can learn and to make sure I will be good at this subject." (Male Cypriot)

Many of the students in Cyprus and England (12 out of 27) also perceived their parents and especially their mothers to encourage them in learning mathematics when they were younger either by helping them with their school work or by

using activities to make mathematics interesting for them. The interview data suggests that parents often encouraged their children in learning mathematics either because they liked mathematics themselves or because they considered it as an important subject.

S4: Students perceive their parents to encourage them in learning mathematics
(12, 12)

In Samia's words:

Samia: "I think so, my mum did. I don't know, I think she used to help us a lot and then we grew to like it [mathematics] and enjoy it and be good at it. So I think because of my young age she used to help us with our school work and stuff, that's why now we like it like doing the school work." (Female Asian British)

Kushal explained:

Kushal: "Um, yeah because my mum always loved maths. Um, she is quite good at it as well. She used to teach me when I was younger, so that really helped me to like mathematics." (Male Asian British)

Similar, Shahzan said:

Shahzan: "Yes, very much so my mum especially. She made me do a lot of maths, because she knew how important it was in later life to do maths and do

well in maths.” (Male Asian British)

Miten also remarked:

Miten: “Um, yes I think they did. Um, I don’t know if this is true for everyone but a lot of Asian families their families motivate them to do maths, they encourage them to do maths. I don’t know why that is. Because I think it [mathematics] is seen as an important subject. Um that’s why, yeah. My family definitely did.”

(Male Asian British)

Giorgos indicated about his parents’ encouragement in learning mathematics:

Giorgos: “. . .at the end of each mathematics exercise they [parents] used to try to help me to understand why that exercise was solved in that way, but not more than that.” (Male Cypriot)

Irene extrapolated her growth in mathematics skills by playing board games with her mother:

Irene: “In order to learn easily my mum when I was in primary school used to play with me board games and with the dices I had to add up the numbers in order to move forwards. If I was doing it [adding up] incorrectly then I had to move backwards and this was not in my benefit. Therefore, I had to learn to do it correctly and I used to like it a lot and this is why I learned it.” (Female Cypriot).

It should be noted that two of the students in Cyprus and two of the students in England did not perceive their parents to encourage them in learning mathematics.

For example, Maria said:

Maria: “No, no at all. They let me on my own to make my own decisions in regards to what my favourite subject was. They never involved in such things.”
(Female Cypriot)

Rafael also said:

Rafael: “No, they never motivated me for any subject.” (Male Cypriot)

Similar, Emilia explained:

Emilia: “Not really. They didn’t really do anything like that, but it was important to be good at mathematics when I was younger.” (Female British)

Sam also said:

Sam: “Um, no I think they pretty much gave up hope on me when I was [laughs] younger. They didn’t think I was going to be good at maths and I think I turned out as a surprise to everyone and me included, when I was um. So, you know it’s something that happened rather than actually coming from parents.”
(Male British)

What was also interesting was that three of the students in England and none of the students in Cyprus perceived their parents' occupation being related to mathematics to have motivated them with regards to mathematics.

For example, Joe said:

Joe: "Um, particularly my dad being a maths teacher. I think that kind of, um that sort of motivates me. They [parents] are not pushing me into it, but they are always doing that sort of mathematics side of things. They are probably the reason I am doing maths at the minute, um yeah." (Male British)

Chintam also indicated:

Chintam: Chintam: ". . . my dad is like an accountant so he does lots of maths, so he pushed me to do lots of maths." (Male Asian British)

Likewise, Jasmeen said:

Jasmeen: "Yeah, my dad did because he is a mechanic and he is good at maths and stuff. So, he did influence me." (Female Asian British)

Moreover, the overwhelming majority of students in Cyprus and students in England (25 out of 27) perceived their mathematics teachers to expect them to do well in mathematics.

S2: Students perceive their mathematics teacher to expect them to do well in

mathematics (25, 25)

Polina was explicit about her mathematics teacher's expectations:

Polina: "She [mathematics teacher] wants everyone to do well in mathematics because we have chosen this subject and this is our final year and it will help us a lot." (Female Cypriot)

Giannis said:

Giannis: "She [mathematics teacher] expects from all of us to do well in mathematics." (Male Cypriot)

Emilia also indicated:

Emilia: "Um, yeah because you do like important stuff so she [mathematics teacher] has like predicted grades for me so she expects me to get them."
(Female British)

Miten also remarked:

Miten: "Yeah, they [mathematics teachers] expect me to get the higher end of the grades rather than the lower end or the middle end. But yeah, yeah they expect me to do well." (Male Asian British)

Some of the students in England (10 out of 16) and some of the students in Cyprus (4 out of 11) expressed positive feelings about their mathematics

teachers. However, these feelings were more often expressed by the students in England. Another noticeable difference was that female students in Cyprus (3 out of 5) more often than male students in Cyprus (1 out of 6) expressed positive feelings about their mathematics teacher. The interview data suggest that students often appreciate a mathematics teacher who has good ways of teaching (such as working at a good pace with students, making mathematics lessons stimulating, helping students, and setting them homework), has an interest in students' success in mathematics, and praises them for their efforts.

S3: Students express positive feelings about their mathematics teacher (14, 14)

In Samia's words:

Samia: "He is quite a good teacher and he like [pause]. Um he will always give us questions to work on so that you know there is nothing if you finish it [mathematics questions] you can carry on you don't have to just sit there doing nothing. I think he does motivate me because even though I am B minus he is motivating me to get a higher grade. So I think that's good I think.

Kushal also said:

Kushal: "Um, I've got an excellent mathematics teacher. She is really helpful and she helps you get to your work and makes you understand it better." (Male Asian British)

Chintam also indicated:

Chintam: “Yeah, she is really good. Um, she has a good way of teaching things and she works at a good pace which is quite good for me as well, because I think she works quite fast and I like working fast in maths as well.” (Male Asian British)

Miten also remarked:

Miten: “Um, I have two teachers and both of them have been really good. They have motivated me because they’ve had high expectations. Before I came to this college I wasn’t the best at maths, but I’ve done much better as I’ve come here and yeah my teachers have been important to motivate me to do well in maths.” (Male Asian British)

Abhilash also said:

Abhilash: “All the maths teachers do. They help beyond the classroom subject. They tell you about what you are going to be doing at uni. So, it really [pause] you really want to do it because it is so interesting. So, they help a lot, if you stuck on a problem they help.” (Male Asian British)

In Maria’s words:

Maria: “Um, most of the mathematics teachers I had so far yes they told me that I had the capability to succeed. They were encouraging me and they believed that I could do it.” (Female Cypriot)

Polina also indicated:

Polina: “Yes, she [mathematics teacher] helps me. She doesn’t do any distinctions. It is not the case that she cares only for some students, she cares for everyone.” (Female Cypriot)

Rafael also said:

Rafael: “Always when you do well in mathematics tests they tell you “Well done, you did well” and they always help you at the end with the grade. Therefore, you feel better for yourself and you try even harder for the next semester or for your exams.” (Male Cypriot)

Some of the students in Cyprus and England (8 out of 27), however, expressed negative feeling about their mathematics teacher. These feelings were more often expressed by students in Cyprus (5 out of 11) than students in England (3 out of 16). It is worth noting that one male and one female student in Cyprus placed additional emphasis on these negative feelings about their mathematics teacher. An evident pattern that emerged from the interview data suggests that students in Cyprus mostly expressed negative feelings about their mathematics teacher at school because of the immense influence of private tuition in Cyprus that diminishes school lessons to “pretend” lessons, whereas students’ in England expressed negative feelings either because of their teacher’s teaching styles (such as lack of stimulation during lessons, and teacher’s inability to transmit knowledge), or teacher’s personality.

S5: Students express negative feelings about their mathematics teacher

(10, 8)

Shahzan said:

Shahzan: “Not especially. He bores me to the fact that I don’t enjoy lessons at all. I’d rather learn things myself. He’s made that way. My last year’s teacher was a lot better. She knew how to teach. This year’s teacher, I don’t enjoy maths at all. I don’t learn anything in class, I teach myself at home. He bores me, and he doesn’t motivate me at all to do well.” (Male Asian British)

Joe also indicated:

Joe: “Um, well I have two and one does and the other doesn’t. Um, [laughs] one I don’t get on with well at all, um but this one [afternoon mathematics school teacher] she is all right and I guess she makes us work harder. Um, but I guess having a maths teacher that you don’t like kind of motivates me as well because I want to prove to them that I can. But, yeah.” (Male British)

Rima also said:

Rima: “Yeah, this one [afternoon mathematics school teacher] does. The other one, sort of. The way he explains is really [pause] in a strange way a bit confusing.” (Female Asian British)

In Vasilis’ words:

Vasilis: “She [mathematics teacher] tries to do her job. She solves mathematics problems, she explains the teaching material, she doesn’t try to make the mathematics lesson more interesting.” (Male Cypriot)

Anna said:

Anna: “No, my school’s mathematics teacher not. But the private lesson’s mathematics teacher approaches me and this helps me.” (Female Cypriot)

Irene also explained:

Irene: “Last year, for example, I like it [mathematics] a lot; I was participating in the classroom because the teacher wanted us to participate. This year because I know most of it from private lessons I feel bored doing the same again and again and we solve mathematics problems all the time and you put the theory into practice but you know at some point especially when we have two hours lessons you say “I can’t take it anymore” you need five minutes to clear your head.” (Female Cypriot)

In addition, Irene said:

Irene: “Well, let’s say that she is not a person that she will support me or she will ask me to solve a mathematics problem on the blackboard and she will encourage me. Of course I think that this has to do with my class, but I don’t like this mathematics teacher.”

As Lucas puts it:

Lucas: “Yes [hesitation]. Basically nowadays every student does private lessons, therefore in the classroom it is quite funny the “pretended lesson” because we know it [teaching material] and the teacher knows that we know it and she basically pretends and we pretend that we don’t know it to go [to the lesson]. Therefore, the mathematics teacher at school plays no role.” (Male Cypriot)

Giorgos also explained:

Giorgos: “This year is still soon to know that I trust my mathematics teacher. It is true that private lessons play a significant role because subconsciously you think that even if I don’t learn it now in the classroom and I don’t understand it I will go to my private lessons in the afternoon.” (Male Cypriot)

Summary of key points

The overwhelming majority of the students in Cyprus and England (25 out of 27) perceived their parents to expect them to do well in mathematics and many of them (12 out of 27) also perceived their parents (and especially their mothers) to encourage them in learning mathematics from a young age either by helping them with their school work or by using activities involving mathematics. It should be noted that students often mentioned in their interviews that their parents perceived mathematics as important. A common perception amongst most of the students in Cyprus and England (25 out of 27) was also that their teachers

expected them to do well in mathematics. The interview data also suggest that many of the students in Cyprus and England (14 out of 27) had positive feelings about their mathematics teacher. However, these feelings were more often expressed by the students in England (10 out of 27). Noticeable differences were also evident between female (3 out of 5) and male (1 out of 6) students in Cyprus. It seems from the data that students often appreciated a teacher who had good ways of teaching, cared about students' success in mathematics, and praised students' for their efforts. The interview data also suggest that some of the students (8 out of 27) had negative feelings about their mathematics teachers. These feelings were more often expressed by the students in Cyprus (5 out of 11). A significant cultural difference that emerged from the interview data was that students in Cyprus expressed negative feelings about their mathematics teacher mostly because of the immense influence of private tuition in Cyprus that often diminished school lessons to "pretend lessons". Students in Cyprus reported lack of stimulation during mathematics lessons at school, because they knew most of the teaching material from their private schools and felt that "the mathematics teacher at school played no role" in their learning of mathematics. Students in England, on the other hand, expressed negative feelings about their mathematics teacher, because of their teacher's teaching styles and personality.

7.3.5 Gender stereotypes

Table 7.5 Frequencies of “Gender stereotypes”

Theme	Male British (n=9)	Female British (n=7)	Male Cypriot (n=6)	Female Cypriot (n=5)
Students perceive girls to be equally good as boys at mathematics	(6, 6)	(3, 3)	(2, 2)	(4, 4)
Students perceive girls to be good at mathematics because they work hard	(0, 0)	(4, 4)	(3, 3)	(0, 0)
Students perceive boys to be naturally good at mathematics	(1, 1)	(2, 2)	(2, 2)	(1, 1)

Note: These are frequencies of those students who expressed any stereotypical view; some of them expressed more than one.

Many studies examining gender-stereotype perceptions of mathematical abilities have shown that primary (e.g. Forgasz, 1992; Tiedemann, 2000a), junior secondary (e.g. Forgasz, 1995), or upper secondary male students (e.g. Jacops, 1991) often believe that their mathematical abilities are superior to those of females. Other studies (e.g. Forgasz & Leder, 1996) showed that most of the students perceive men and women as equally proficient. The most common view expressed in this study by the students in Cyprus and England (15 out of 27) was that they perceived girls to be equally as good as boys at mathematics.

St1: Students perceive girls to be equally good as boys at mathematics (15, 15)

In Sneha's words:

Sneha: "I think girls can be as good as boys, because like me and my brother we do equally good." (Female Asian British)

Kushal also said:

Kushal: "Yeah, definitely they can be equally good as each other. It doesn't matter what you are at the end whether you are a boy or a girl. It makes as equal." (Male Asian British)

Although Sam shared the same view as the others, referred to the dominance of male mathematicians in higher levels:

Sam: "Um, I think that girls can be as good as boys at mathematics. Um, but I do tend to see that they seem to be more male mathematicians at higher level and I don't know why that is. Maybe it's less attractive as a subject and I mean if that's the case there are certain subjects that you get a higher concentration in women and certain subjects that you get a higher concentration in men. And maybe I mean that's a question for psychologists, I suppose [pause]. I don't really know why that is." (Male British)

Anna said:

Anna: "No, because boys and girls have the capability to do their best at mathematics." (Female Cypriot)

Similarly, Vasilis indicated:

Vasilis: “No, they are the same. Gender doesn’t make a difference.” (Male Cypriot)

Irene referred to her school’s corps, which was formed mainly of girls who were doing advanced physics to justify her account:

Irene: “I don’t want to be characterised as feminist or racist. Boys and girls are the same. I have noticed though that my school’s corps [in Cyprus a school corps is composed of high achieving students that represent their school in national celebrations] is always formed of girls who are doing advance physics and many have shown that girls are more intelligent in this kind of fields. So, I don’t agree that boys are better.” (Female Cypriot)

Some of the male students in Cyprus (3 out of 6) and female students in England (4 out of 7) perceived girls to be good at mathematics because they work hard. This view was not expressed by any female student in Cyprus or any male student in England.

St2: Students perceive girls to be good at mathematics because they work hard
(7, 7)

Giannis said:

Giannis: “No, girls perform well in mathematics and some of them are better

than boys. It might be that they study more than boys; they participate [in the classroom] more than boys.” (Male Cypriot)

Rafael also noted:

Rafael: “I think that they are almost the same, but usually girls pay more attention in the classroom, study harder, therefore usually they get better grades than boys.” (Male Cypriot)

Rina did not think of boys as better than girls at mathematics:

Rina: “No [laughs], not at all no. I think girls are, girls could [pause]. I think girls work more.” (Female Asian British)

A small number of students in Cyprus (3 out of 11) and a small number of students in England (3 out of 16) perceived boys to be naturally good at mathematics. This view was expressed mainly by male students in Cyprus (2 out of 6) and female students in England (2 out of 7). Students justify their accounts by making remarks such as girls work harder than boys at mathematics, there is a difference in their brains and how they work, girls are more “language people”, or “the most important mathematicians are men”.

St3: Students perceive boys to be naturally good at mathematics (6, 6)

In Yasmeen’s words:

Yasmeen: “They can be as good as boys. They just need more practice. Boys are just naturally, um like as how as it happens. I think girls can be as good as boys.” (Female Asian British)

Emilia also explained:

Emilia: “I think girls can be as good as boys at mathematics, but [pause]. I don’t know, like most of the girls that are good at maths are girls that just put a lot of work into it and study hard. But then some boys, they just seem like they’ve got a difference of mind and how they work. They are just more logical, I think. I don’t know they are just [pause]. Yeah, I think that they don’t work as hard as girls, but they have a more logical mind. Some boys, really. I am not like just generalizing, but yeah.” (Female British)

Shyam also remarked:

Shyam: “Um, I think naturally maybe boys have a site of maths whereas girls are more English based, but when you know [pause]. Girls can do mathematics if they want, but then are naturally more writing people, talking people rather than you know problem solving I mean. But if they want to do it, they can do it as well.” (Male Asian British)

Lucas also perceived boys to be naturally good at mathematics:

Lucas: “Um, I think yes. Usually boys are better at mathematics, but girls study more because they have realised that we are in the final year and they study

more than boys. But if we put them together without having a mathematics book to study I think that boys would have done a lot better, I think that boys are naturally better at mathematics.” (Male Cypriot)

Likewise, Giorgos explained:

Giorgos: “It depends what we mean by saying mathematics. When someone means simple or difficult mathematics problems that we find in a book then I don’t see any difference. I have female friends that are much better in mathematics than me. If however we are talking about mathematics that we find in our life and we experience in many things, I think that apart from mathematics problems, the pen, and the book in our everyday life a boy will think more practically and he will use more simple mathematics in order to solve a problem than a girl.” (Male Cypriot)

Maria also said:

Maria: “The most important mathematicians are boys, this could be of their natural ability, but girls can do equally well if they try.” (Female Cypriot)

It is worth mentioning that there was one male student in England who although did not think of boys being better than girls at mathematics, he thought that there was a difference in their brains.

In Joe’s words:

Joe: “Um, I don’t [pause]. My first inclination is to say no. Um, I don’t see why, but I guess that is sort of like [pause]. I suppose girls’ brains work differently to boys’ brains. I don’t know enough about psychology to know how, what difference is in the way brains work between genders to know if there is a difference. (Male British)

In addition, another male student in England mentioned that in the past he used to think of boys being better at mathematics because girls were not supporting mathematics as much as boys did.

In Bhavik’s words:

Bhavik: “Um, I would say in the past boys were better simply because girls didn’t support maths as much. But now [pause]. It depends what sort of maths is. I think girls tend to be better at stats [statistics] and boys tend to be better at mechanics simply because mechanics is more orientated to people who do physics and more boys do physics. I don’t know why that is, why more boys do happen to do physics but it is the truth. So for that reason I think that boys could be better at mechanics and girls could be better at stats because they tend to go for biology and chemistry as opposed to physics and science. (Male Asian British)

Summary of key points

The most common view expressed in this study by the students in Cyprus and England (15 out of 15) was that they perceived girls to be equally as good as boys at mathematics. One male student in England who expressed this view, however, referred to the higher concentration of male mathematicians in higher levels in England. A similar observation was not indicated by any of the students in Cyprus. One female student in Cyprus, on the other hand, who perceived boys and girls to be equally good as each other at mathematics justified her account by pointing out that her school's corps was mostly formed of high achieving girls who were doing advanced physics. Some of the students in Cyprus and England (7 out of 27) perceived girls to be good at mathematics because they work hard. This view was expressed mainly by female students in England (4 out of 7) and some male students in Cyprus (3 out of 6). None of the male students in England or the female students in Cyprus supported this view. In addition, a small number of students in Cyprus (3 out of 11) and a small number of students in England (3 out of 16) also perceived boys to be naturally good at mathematics. This view was expressed more often by male students in Cyprus (2 out of 6) and female students in England (2 out of 7).

CHAPTER 8

SUMMARY AND DISCUSSION OF FINDINGS

8.1 Overview of Chapter 8

In this chapter, the study will be briefly summarised. A reference to the study's limitations will follow, and then a discussion and conclusions on the findings will be made. In addition, the implications of the study for researchers and educators will be outlined. Finally, this discussion will be followed by suggestions for future research.

8.2 A brief synopsis of the study

Gender differences in mathematics participation and achievement have concerned researchers from all over the world for many decades. Researchers have been proposing various explanations as to why there are gender differences in mathematics participation, performance, and achievement. These explanations include varied and multi-level complex individual internal-related factors (such as cognitive and affective characteristics), and external environment-related factors (such as family, school, and society) whose influences change in character and importance across the life course (Byrnes, 2005; Ceci & Williams, 2007; Halpern et al. 2007). The present study aimed to examine differences or similarities between male and female students in Cyprus and England in terms of their attitudes towards mathematics and compare them within and across the two countries. In addition, the study aimed to explore how

social factors (such as parents and teachers) influence male and female students' attitudes towards mathematics in Cyprus and England. The assumption here is that the influence of social factors can have an impact on students' attitudes towards mathematics. This influence may vary between male and female students within countries, and at the same time may be different for students of the same gender between the two countries.

Female students in Cyprus are more inclined to choose to study mathematics at university level (Department of Statistics and Research, 2009) than female students in England who choose to study caring or art/humanities/social sciences subjects instead (Francis, 2002; Smithers & Robinson, 2006). Of primary interest of this study was a better understanding of the differences in attitudes towards mathematics between female students in Cyprus and female students in England that may provide an insight into the relationship between attitudes and female students' enrolment in advanced level mathematics, and their intentions to continue enrolment in mathematics, and mathematics-related courses in higher levels. In order to understand gender differences in participation in mathematics and mathematics related careers between students in Cyprus and students in England the present study adopts a socio-cultural explanation. The internal factor studied is students' attitudes towards mathematics and their relationship to external environment-related factors (as perceived by the students), in particular to parents and teachers' influence on students' attitudes towards mathematics.

The research questions that guided this study were:

1. Are there differences and/or similarities between students in Cyprus and England in terms of attitudes towards mathematics?
2.
 - a) Are there differences between male and female students in Cyprus in terms of attitudes towards mathematics?
 - b) Are there differences between male and female students in England in terms of attitudes towards mathematics?
 - c) If there are, how do these differences compare across the two countries?
3. How do social factors influence the attitudes of male and female students in Cyprus and England towards mathematics?

Participants were 17- to 18 year-old secondary school students from Cyprus who were taking advanced mathematics (in the final year of upper secondary school), and sixth-form college students from England of the same age who were also taking advanced and further advanced mathematics. Data were collected through a questionnaire and student interviews. The questionnaire was administered to all the students in Cyprus who were opting advanced mathematics at the secondary school under study (62 students) and to all the students in England at the college under study as soon as they finished their AS-level mathematics examination and were planning to take A-level mathematics (363 students). Interviews were conducted with eleven (6 boys and 5 girls) high achieving students in Cyprus taking advanced mathematics and sixteen high achieving students in England taking advanced and further advanced mathematics. Eight

(5 boys and 3 girls) of the students in England were doing advanced level mathematics and eight (4 boys and 4 girls) of them were doing further advanced mathematics. The initial plan was to interview only ten (5 boys and 5 girls) students in each country who were doing advanced level mathematics, however a decision was made later to include interviews from all the students who volunteered to be interviewed.

The study employs mixed methods to provide comprehensive answers to the research questions. The rationale is to juxtapose the findings from the analysis of the questionnaire data and the findings from the interview data in order generate complementary insights that together will create a bigger picture. Factor Analysis was employed for the questionnaire data (a decision was made to select data randomly from 100 questionnaires administered to the students in England, while retaining all the questionnaire data from the 62 students in Cyprus-the reason for doing this was explained in Chapter 6). Factor Analysis was followed by multivariate analysis of variance (MANOVA) and post-hoc tests. Mean scores of students' responses on the statements (items) of the questionnaire that formed each of the six attitudinal factors extracted from Factor Analysis were demonstrated in tables to have a general idea about students' attitudes and detect possible trends between the gender groups. In addition, the statistically significant findings found from post-hoc tests were further explained using illustrative graphs and tables of students' responses in percentages.

Student interviews from each country were first transcribed (the Greek interview transcripts were also translated into English), and the texts from students' interview transcripts were then analysed using thematic analysis. In order to identify frequencies of themes for each interviewee and across the whole body of interviewees I adopted a method by Nardi and Steward (2003; see Chapter 6). Consequently, each theme was assigned an ordered pair (x, y) as follows: x corresponds to the number of times the theme has been identified in the coded interview transcript, and y to the number of students who have referred to the theme. The themes emerged from the data were categorised into five theme headings according to commonality and findings from the analysis of interview data were reported and discussed in the five theme headings with tables that illustrated frequencies of each theme by students' gender in each country. Each theme was accompanied by its (x, y) frequency ordered pair, and discussed using extracts from students' interview transcripts.

8.3 Limitations of the study

I acknowledge that there are a number of limitations in this study due to the nature of the sample, methods of the data collection and analysis, as well as the researcher's personal values and preferences. Firstly, the sample of the study was an opportunity sample, whereby only those who volunteered to participate were included. In addition, sampling was restricted to one city in England (East Midlands) and one city in Cyprus (Nicosia). Therefore, the lack of a

geographically distributed sampling, necessitated by the limited resources available to the researcher, also limits the representativeness of the sample. Therefore, the overall findings of this study are limited in representativeness and generalisability. However, the main aim of the study was not to generalise differences in attitudes towards mathematics between male and female students within Cyprus and England and across the two countries, but to gain a better understanding of the possible influences and causes of gender differences in attitudes towards mathematics. Secondly, the study only compared the attitudes of high-achieving students (preferably students with A or B grades in mathematics) from a high socioeconomic background opting for advanced level mathematics from one college in England and one Lyceum in Cyprus. Therefore, the findings of this study are limited to middle-class, high-achieving students from these two countries only. These findings are not generalisable to the entire population of students from both countries. Thirdly, the study only involved a Likert-scale questionnaire administered to students and a semi-structured interview with students as methods of data collection. Both the questionnaire and the interview were examining the same attitudinal domains. However, if the study involved also interviews with parents and teachers, we would have gained a better understanding into the relationship between social influence (parental/teacher) and gender differences in attitudes towards mathematics.

Clearly, these are significant limitations to this study, and the above list may well not be exhaustive. However, I believe there are a lot to be learnt from this study

both in the realms of improved methods and future studies as well as in the actual findings of the study.

8.4 Conclusions and Discussion

In Chapter 6, statistically significant differences were found on students' attitudes in two attitudinal domains that of 'students' perceptions of mathematics as a male domain' and that of 'students' perceptions of their parents' expectations with regards to mathematics'. In addition, by looking at the mean scores of students' responses on the statements of the questionnaire that formed the six attitudinal domains extracted from Factor Analysis some interesting trends between the gender groups were identified. In Chapter 7, the themes that emerged from the data allowed a further understanding to the findings of the questionnaire data. In this chapter, findings from both the questionnaire and the interview data will be combined in order to answer the research questions of the study. Findings from the study will be also related to the relevant literature.

8.4.1 Are there differences and/or similarities between students in Cyprus and students in England in terms of attitudes towards mathematics?

Findings from the interview data showed that the overwhelming majority of the students in Cyprus and England perceived mathematics useful in their lives and most of them found it interesting and enjoyable when it is challenging. According to many (e.g. Brown et al. 2008; Nardi and Steward, 2003; Williams and Ivey, 2001) perceived dislike, boredom, and lack of relevance are important reasons

for students not continuing with mathematics. Others (e.g. Meyer & Kohler, 1990; Chipman, 2005) also support that perceived usefulness of mathematics is strongly associated with mathematics participation and achievement. The students who participated in this study were all high achievers opting for advanced level mathematics. This may suggest that students who excel and choose mathematics at advanced level have a utilitarian view of mathematics perhaps because students experience mathematics as useful in the classroom or in their everyday life. I should note that findings from the questionnaire data also showed no statistically significant difference between students in Cyprus and England in terms of their enjoyment of mathematics.

In addition, findings from the interview data suggested that both students in Cyprus and England were motivated to do well in mathematics in order to get the grades that would allow them to pursue studies at university. The students in Cyprus, however, more often expressed this view. This might suggest that students' perceived usefulness of mathematics, particularly for career prospects, possibly relates to students' desire to do well in mathematics in order to follow studies at university. In addition, many of the students in Cyprus and England were motivated to do well in mathematics because they liked mathematics. A small number of students from both countries also expressed their desire to do well in mathematics for personal satisfaction.

Moreover, findings from the interview data suggested that both students in Cyprus and England perceived their abilities in mathematics as strong. Students from both countries also expressed that they felt confident in their abilities in mathematics when practiced mathematics, and some of them expressed that their confidence in their abilities in mathematics depended on the difficulty of a mathematics problem. Findings from the questionnaire data also showed that there weren't any statistically significant differences between students in Cyprus and England in terms of their confidence in their mathematical abilities. Students' confidence in their abilities in mathematics can possibly explain why they have chosen to do mathematics at advanced level. In fact, students' confidence in their abilities in mathematics has often been associated with students' participation in mathematics course taking and career aspirations in mathematics-related fields (e.g. Meyer and Koehler, 1990; Burton, 2001; Ireson, Hallam and Plewis, 2001).

Findings from the interview data also showed that the overwhelming majority of the students in Cyprus and England did not express feelings of anxiety when solving mathematics problems. Only a small number of students in Cyprus and England expressed feelings of anxiety when mathematics problems were difficult to solve. According to Garry (2005), students who are maths anxious have little confidence in their ability to do mathematics and tend to take the minimum amount of required mathematics courses and this limits their career choice options. As I said earlier, findings from the interview data showed that the students in both countries felt strong about their abilities in mathematics, and

often felt confident when practising mathematics. Therefore, this may suggest that most of the students in both countries did not express feelings of anxiety, because they often felt confident in their abilities in mathematics.

In addition, both students in Cyprus and England in their interviews attributed good performance in mathematics to practice, enjoyment of mathematics, natural ability, and mathematics teacher. A noticeable difference between students in Cyprus and England, however, was that students in England more often than students in Cyprus attributed good performance in mathematics to enjoyment of mathematics.

Findings from the interview data also showed that the overwhelming majority of students in Cyprus and England perceived their parents to expect them to do well in mathematics. In addition, many of them perceived their parents to have encouraged them in learning mathematics when they were younger either by helping them with their homework or by using activities to make mathematics interesting for them. Parental influence, such as parental encouragement, parental expectation, and parents' attitudes towards mathematics, has been identified in the literature as having a significant impact on students' attitudes towards mathematics (e.g. Catsambis & Suazo-Garcia, 1999; Ma 2001; Wang et al. 1996; Zeldin & Pajares, 2000). Findings from the interview data of this study showed that both students in Cyprus and England had positive attitudes towards mathematics (i.e. perceived mathematics useful and interesting, expressed

desire to follow mathematics-related studies at university etc.). We might speculate that these positive attitudes are intimately bound up with parental expectation and encouragement:

Samia: “I think so, my mum did. I don’t know, I think she used to help us a lot and then we grew to like it [mathematics] and enjoy it and be good at it. So I think because of my young age she used to help us with our school work and stuff, that’s why now we like it like doing the school work.” (Female Asian British)

I should note that findings from the questionnaire data, however, showed statistically significant differences in ‘students’ perceptions of their parents’ expectations’. These differences were found between male students in Cyprus and female students in England, and between female students in Cyprus and female students in England. Specifically, both male and female students in Cyprus supported more strongly that their parents had expectations from them regarding mathematics than female students in England. What was noticeable though from students’ responses on the questionnaire statements was that students in Cyprus had more often a tendency to ‘strongly agree’ or ‘strongly disagree’, whereas students in England were more often neutral or inclined to ‘agree’ or ‘disagree’. Tendencies in the way students from different groups (such as gender groups or ethnic groups) reply on the questionnaire statements are likely to produce statistically significant differences, even when both students in

Cyprus and England have a positive perception of their parents' expectations of them concerning mathematics.

Findings from this study regarding parental influence (as perceived by the students) contradict to some extent findings from Kleanthous and Williams (2009). Kleanthous and Williams' (2009) mixed-method study that involved students from both Cyprus and England investigating their dispositions to study further mathematics in higher education, revealed cultural differences in the ways students perceive parental influence. Specifically, findings from their study revealed that perceived parental aspirations had no statistically significant effect on Cypriot and White British students' dispositions to study further mathematics. In addition, evidence from the qualitative data indicated a subtle parental influence often 'denied' for both Cypriot and White British students. However, for ethnic minority students in England there was a statistically significant effect on students' dispositions to study further mathematics. The interviews also revealed that ethnic minority students tended to say that their family strongly motivated them.

The present study did not show any cultural differences in the ways students' perceived parental encouragement and expectations concerning mathematics. Both the students in Cyprus and students in England (Whites and Asians) perceived their parents to expect them to do well in mathematics. Many of them also perceived their parents to encourage them from a young age in learning

mathematics either by helping them with their schoolwork, or by using activities to make mathematics interesting for them. Only two students in Cyprus and two students in England (2 out of the 3 White British students interviewed) indicated that they were not encouraged by their parents in learning mathematics. However, these students indicated that it was important for their parents to do well in mathematics. The only similarity between the findings from this study and the findings from Kleanthous and Williams' (2009) study is that Asian students tended to say that they were strongly encouraged by their family:

Miten: "Um, yes I think they did. Um, I don't know if this is true for everyone but a lot of Asian families their families motivate them to do maths, they encourage them to do maths. I don't know why that is. Because I think it [mathematics] is seen as an important subject. Um that's why, yeah. My family definitely did."

(Male Asian British)

Findings from the interview data showed that the overwhelming majority of students in Cyprus and England perceived their mathematics teacher to expect them to do well in mathematics. In addition, both students in Cyprus and students in England expressed positive feelings about their mathematics teacher. These feelings, however, were more often expressed by the students in England. The interview data also suggested that students often appreciated a mathematics teacher who had good ways of teaching (such as working at a good pace with students, making mathematics lessons stimulating, helping students, and setting them homework), had an interest in students' success in mathematics, and

praised them for their efforts. Findings from the questionnaire data also did not show any statistically significant differences between students in Cyprus and England in terms of their perceptions of their mathematics teacher's expectations. However, the mean scores of students' responses on the statements of the questionnaire that formed the attitudinal factor 'students' perceptions of their mathematics teacher's expectations' showed some interesting trends between the students in Cyprus and the students in England. For example, on the statement 'My mathematics teacher thinks mathematics will help me get a good job' male and female students in Cyprus tended to 'strongly agree', whereas male and female students in England tended to 'agree'. Moreover, on the statement 'My mathematics teacher believes in my mathematical abilities' male and female students in Cyprus agreed, whereas male and female students in England tended to agree.

A QCA (2005) study in England, carried out by Matthews and Pepper that involved AS and A2 students, A level students who had dropped out from GCE mathematics courses, and A level students who gained good grades in mathematics at GCSE showed that for those students who dropped GCE mathematics enjoyment of mathematics was linked to teaching (the same applied for AS and A2 students). A group of the students indicated that they had not enjoyed GCSE because they had been 'poorly taught', the teaching focussed on how to 'pass the exam' and they could not see the worth of the coursework.

As I already mentioned the interview data showed that many of the students in Cyprus and England expressed desire to do well in mathematics in order to follow mathematics-related studies at university level. We can assume that the positive influence of mathematics teachers on students' mathematics learning (as perceived by the students) can possibly relate with students' desire to pursue further studies in mathematics:

Abhilash: "All the maths teachers do. They help beyond the classroom subject. They tell you about what you are going to be doing at uni. So, it really [pause] you really want to do it because it is so interesting. . ." (Male Asian British)

Findings from the questionnaire data did not show a statistically significant effect on 'students' negative perceptions of their mathematics teacher's expectations' between students in Cyprus and England. However, some (8 out of 27) of the students in Cyprus and England expressed in their interviews negative feelings about their mathematics teachers. A significant cultural difference that emerged from the interview data was that students in Cyprus mostly expressed negative feelings about their mathematics teacher at school because of the immense influence of private tuition in Cyprus that diminishes school lessons to "pretend" lessons. On the other hand, students in England expressed negative feelings about their mathematics teacher because of either their teacher's teaching styles (such as lack of stimulation during lessons, and teacher's inability to transmit knowledge) or teacher's personality. It seems that role-modelling and intellectual respect for the students in Cyprus was transferred outside the classroom and to

the private tutors. Therefore, students in Cyprus relied more on their private tutors instead of their school teachers:

Lucas: “Yes [hesitation]. Basically nowadays every student does private lessons, therefore in the classroom it is quite *funny* the “pretended lesson” because we know it [teaching material] and the teacher knows that we know it and she basically pretends and we pretend that we don’t know it to go [to the lesson]. Therefore, the mathematics teacher at school plays no role.” (Male Cypriot)

It is worth noting that the majority of those students in England who expressed negative feelings towards their mathematics teacher were further advanced mathematics students who had two mathematics teachers at school. These students expressed negative feelings only for one of their mathematics teachers often by comparing him/her to the other teacher:

Joe: “Um, well I have two and one does and the other doesn’t. Um, [laughs] one I don’t get on with well at all, um but this one [afternoon mathematics school teacher] she is all right and I guess she makes us work harder. Um, but I guess having a maths teacher that you don’t like kind of motivates me as well because I want to prove to them that I can. But, yeah.” (Male British)

Joe expressed negative feelings towards one of his mathematics teachers because of his personality (he did not get on with him well) and because of his teaching style, (he did not make him work as hard as his other mathematics

teacher did). What is more interesting, however, is that in Joe's case the negative feelings towards his mathematics teacher were turned into positive ones by motivating Joe to do well in mathematics in order to prove to his mathematics teacher that he had the ability to do so. This may suggest that even if students experience mathematics learning negatively, for example through a bad mathematics teacher, it does not necessarily mean that this will have a negative impact on students' attitude towards mathematics. Students to some extent can influence their own attitudes towards mathematics as well by being interested in, motivated to, confident enough to learn mathematics (e.g. Hannula, Maijala, & Pehkonen, 2004).

8.4.2 Are there differences between male and female students in Cyprus in terms of attitudes towards mathematics?

The questionnaire data did not show a statistically significant effect on 'students' enjoyment of mathematics' between male and female students in Cyprus. The only noticeable trend found in the data when comparing the mean scores of students' responses to the questionnaire statements that formed the attitudinal factor 'students' enjoyment of mathematics' was that male students in Cyprus felt more strongly with the statement 'I like mathematics' than the female students in Cyprus. The interview data showed that although both male (4 out of 7) and female (4 out of 5) students in Cyprus perceived mathematics as an interesting subject, female students in Cyprus (3 out of 5) more often than male students in Cyprus (1 out of 6) perceived mathematics as an enjoyable subject because it is

challenging. Nevertheless, both the findings from the questionnaire and the interview data suggest that both male and female students in Cyprus involved in this study enjoyed mathematics.

Findings from the questionnaire data did not show a significant effect on 'students' confidence in mathematics' between male and female students in Cyprus. However, when comparing the mean scores of students' responses to the questionnaire statements on this attitudinal factor, a noticeable trend between male and female students emerged. For example, female students in Cyprus felt more strongly with the statement 'I am good at mathematics' than male students in Cyprus. On the other hand, both male and female students in Cyprus felt strongly with the statement 'I am able to solve mathematics problems without too much difficulty'. The interview data also suggested that an equal number of male and female students in Cyprus perceived their abilities in mathematics as strong. On the other hand, male students more often than female students in Cyprus expressed that they felt confident in their abilities in mathematics when practising mathematics.

Moreover, the interview data also showed some interesting trends in the ways male and female students in Cyprus attributed good performance in mathematics. For example, female students in Cyprus (3 out of 5) more often than male students in Cyprus (2 out of 6) attributed good performance in mathematics to practice, whereas some of the male students in Cyprus (3 out of

6) attributed good performance in mathematics to ability and none of the female students in Cyprus did. Findings from this study agree to some extent with findings from Georgiou, Stavrinides, and Kalavana (2007) study. Georgiou et al. study involved 14-year-old Greek-Cypriot students from 10 junior high schools in Nicosia examining their attributions of mathematics achievement and their attitudes towards mathematics (how attractive and useful mathematics was) using a questionnaire measuring attitudes and attributions, a test of mathematics achievement, and a questionnaire measuring students' affective reactions to the mathematics examination. Georgiou et al. study showed that high achieving boys had a significantly higher mean score in ability attributions than high achieving girls. High achieving girls, however, did not have significantly higher mean score in effort attributions than high achieving boys. In addition, this study showed that high achieving boys did not have significantly higher mean score in attitude (attraction) towards mathematics in comparison to high achieving girls. It seems that similar attributions in performance in mathematics hold true higher up the age range. The present study also found a difference between high achieving male and female students in Cyprus when attributing good performance in mathematics to natural ability. In addition, although the present study showed that female students in Cyprus (3 out of 5) more often than male students in Cyprus (2 out of 6) attributed good performance in mathematics to practice this difference was not significant.

Findings from the questionnaire data showed statistically significant differences between male and female students in Cyprus in their perceptions of mathematics as a male domain. For example, an equal percentage (23.3%) of male students in Cyprus was neutral or agreed with the statement 'Female students are as good as male students when solving a maths problem'. On the other hand, 56.2% of female students in Cyprus strongly agreed with this statement. In addition, male students tended to agree with the statement 'Male students are better at maths than female students', whereas female students in Cyprus tended to 'strongly disagree'. Findings from the interview data also showed that female students in Cyprus (4 out of 5) more often than male students in Cyprus (2 out of 6) perceived girls to be equally good as boys at mathematics. Many of the male students, however, perceived girls to be good at mathematics because they work hard and some of them perceived that boys are naturally good at mathematics. It should be noted that the two (out of 3) male students in Cyprus who perceived boys to be naturally good at mathematics attributed good performance in mathematics to their natural ability. Only one female student in Cyprus perceived boys to be naturally good at mathematics. This student attributed her good performance to her enjoyment of mathematics.

Both the questionnaire and interview data suggested that male students in Cyprus perceived boys abilities in mathematics superior to those of girls:

Lucas: "Usually boys are better at mathematics, but girls study more because

they have realised that we are in the final year and they study more than boys. But if we put them together without having a mathematics book to study, I think that boys would have done a lot better. I think that boys are naturally better at mathematics.” (Male Cypriot)

On the other hand, both the questionnaire and the interview data suggested that female students in Cyprus had a less stereotypical view of mathematical ability in comparison to male students in Cyprus. The reason for this may be that girls in Cyprus who choose to study mathematics at advanced level do not consider or experience mathematics as a male area:

Irene: “I don’t want to be characterised as feminist or racist. Boys and girls are the same. I have noticed though that my school’s corps [in Cyprus a school corps is composed of high achieving students that represent their school in national celebrations] is always formed of girls who are doing advance physics and many have shown that girls are more intelligent in this kind of fields. So, I don’t agree that boys are better.” (Female Cypriot)

Therefore, we might speculate that girls in Cyprus who participate in higher-level mathematics have less stereotypical perceptions of mathematical ability than those girls who choose to opt out. Moreover, their perceived usefulness of and interest in mathematics, and their confidence in their abilities in mathematics may also explain why they choose mathematics at advanced level and express desire to pursue mathematics-related studies at university level.

8.4.3 Are there differences between male and female students in England in terms of attitudes towards mathematics?

The interview data showed an interesting trend between male and female students in England in terms of their motivation. Specifically, male students in England (5 out of 9) more often than female students in England (3 out of 7) expressed that they were motivated to do well in mathematics because they needed good grades that would allow them to pursue studies at university level. Matthews and Pepper (2005) reported a similar finding. Matthews and Pepper study that involved AS and A2 students, A level students who had dropped out from GCE mathematics courses, and A level students who gained good grades in mathematics at GCSE, showed that 22% of male students and only 12% of female students felt that their career was a key reason for choosing GCE Mathematics.

Findings from the questionnaire data showed that 'students' confidence in their mathematical abilities' had no statistically significant effect between male and female students in England. When comparing the mean scores of students' responses to the questionnaire statements that formed this attitudinal factor there was a noticeable trend between male and female students in England on the statement 'I am good at mathematics': male students in England more often than female students in England tended to agree with the statement 'I am good at mathematics'. The interview data also suggested that male students in England (7 out of 9) more often than female students in England (4 out of 7) perceived

their abilities in mathematics as strong. Male students in England (4 out of 9) also more often than female students in England (2 out of 7) expressed that they felt more confident when practised mathematics. Mendick (2005a) reported similar findings. When Mendick interviewed 42 male and female students aged between 16- and 19-years-old and one mature student in England who were opting for advanced mathematics, found no differences between them in terms of their confidence in their mathematical abilities. However, 4 out of the 43 students who were interviewed self-identified as 'good at maths'. All four students were male.

The interview data also showed that both male and female students in England attributed good performance in mathematics to practice, enjoyment of mathematics, and mathematics teacher. An interesting difference, however, between male and female students in England shown from the interview data was that two of the female students in England attributed good performance in mathematics to natural ability and none of the male students in England did. These findings challenge findings from previous research in England. For example, Lightbody et al. (1996) study which involved 1068 secondary school students who completed a questionnaire concerned with enjoyment of school, enjoyment of subjects, and students' attributions to academic success showed that secondary school female students rated hard work and teachers' liking to be more important for their academic success than secondary male students. Secondary male students, on the other hand, rated cleverness, talent, and luck to be more important. It is worth noting, though, that findings from the present study

were for high achieving students opting for advanced level mathematics. Therefore, it is likely that these findings do not agree with findings from Lightbody et al. (1996) study possibly, because the students involved in this study were older and of different mathematical ability than those involved in Lightbody et al. study.

Findings from the questionnaire data showed statistically significant differences between male and female students in England in terms of their perceptions of mathematics as a male domain. Specifically, mean scores of students' responses on the statement 'Female students are as good as male students when solving a maths problem' showed that male students in England were neutral, whereas female students in England tended to 'strongly agree'. On the other hand, mean scores of students' responses on the statement 'Male students are better at maths than female students', showed that male students in England tended to agree, whereas female students in England disagreed. Findings from the interview data also showed that male students in England (6 out of 9) more often than female students in England (4 out of 7) perceived girls to be equally good as boys at mathematics. Many of the females students in England (4 out of 7), however, perceived that girls were good at mathematics because they worked hard. I should note that none of the male students in England expressed this view. In addition, findings from the interview data showed that female students in England (2 out of 7) more often than male students in England (1 out of 9) perceived boys to be naturally good at mathematics. These findings suggest that

male students in England did not perceive their mathematical ability as superior to that of female students in England. On the other hand, it seems that female students in England perceived girls to be good at mathematics because they worked hard and not because of their natural ability.

Of interest, however, are remarks made by male students in England. For example, one male student although he perceived girls to be as good as boys at mathematics he referred to the dominance of male students in higher-level mathematics. Another male student also perceived girls and boys to have a difference in the way their brains work. In addition, a male student said that he used to perceive that boys were better at mathematics than girls were, because girls did not support mathematics as much as boys did in the past. Moreover, there was another male student who perceived girls as “naturally more writing people” and “English based” rather than “problem solving”. It seems that mathematics is an area of strong male significance in a symbolic sense (i.e. images of male students’ dominance in higher level mathematics, or thoughts about males being naturally good at mathematics and girls being naturally good at English, or girls being good at mathematics because they work hard) for both male and female students in England.

8.4.4 If there are differences, how do they compare across the two countries?

(i) Differences between female students in Cyprus and female students in

England

The interview data suggested that female students in Cyprus (5 out of 5) more often than female students in England (3 out of 7) expressed their desire to do well in mathematics in order to follow mathematics-related studies at university (5 out of 5). It seems, though, that female students in England (5 out of 7) were more often motivated to do well in mathematics because they liked mathematics. In addition, the mean scores of female students' responses on the statement of the questionnaire 'I would like to use mathematics at university' indicated that female students in England were neutral, whereas female students in Cyprus agreed with it. These findings suggest that female students in England were more likely to choose mathematics at advanced level because they were interested in the subject rather than because they wanted to pursue mathematics-related studies at university. This can possibly explain why female students in England participate less in mathematics and often follow studies in non-mathematics related fields (e.g. Francis, 2002; Smithers & Robinson, 2006).

Although the attitudinal factor 'students' confidence in their mathematical abilities' did not show a statistically significant difference between female students in Cyprus and female students in England, the mean scores of students' responses showed some interesting trends between them. For example, female students in Cyprus 'agreed' with the statement of the questionnaire 'I am good at mathematics', whereas female students in England tended to 'agree' with it. In addition, it seemed that although both female students in Cyprus and female

students in England tended to 'agree' with the statement 'I am able to solve mathematics problems without too much difficulty' female students in Cyprus felt more strongly about it. On the other hand, findings from the interview data showed that female students in England (4 out of 7) more often than female students in Cyprus (2 out of 5) perceived their abilities in mathematics as strong. Moreover, two female students in England (2 out of 7) attributed good performance in mathematics to natural ability, whereas none of the female students in Cyprus did. It seemed, though, that female students in Cyprus (3 out of 5) more often than female students in England (2 out of 7) attributed good performance in mathematics to practice. This may suggest that female students in Cyprus often felt confident in their mathematical abilities because they practised mathematics (I should note that some of them also referred to enjoyment of mathematics and the mathematics teacher).

The questionnaire data showed a statistically significant difference between female students in Cyprus and female students in England in terms of their perceptions of their parents' expectations about mathematics. The mean scores of female students' responses on the statements of questionnaire 'My parents think mathematics will help me get a good job', 'My parents think mathematics will help me with my future career', and 'My parents have been always interested in my progress in mathematics' showed that female students in England tended to agree, whereas female students in Cyprus tended to strongly agree with them. The interview data, however, showed that both female students in Cyprus and

female students in England perceived their parents to expect them to do well in mathematics and many of them indicated that their parents encouraged them from a young age to learn mathematics. A possible reason why findings from the questionnaire data did not confirm findings from the interview data could be that female students in Cyprus often had a tendency to 'strongly agree' with the statements of the questionnaire, whereas female students in England had a tendency to either be neutral or agree with them. These tendencies can produce statistically significant differences.

Finding from the questionnaire data also showed some interesting trends on the attitudinal factor 'students' perceptions of mathematics as a male domain or not' between female students in Cyprus and female students in England. For example, on the statement 'Female students are as good as male students when solving mathematics problems' both female students in Cyprus and female students in England tended to 'strongly agree'. On the other hand, on the statement 'Male students are better at mathematics than female students' students responses in percentages showed that female students in Cyprus (65%) more often than female students in England (44%) strongly disagreed with it. It is worth noting also that 6% of female students in England agreed and another 6% of them strongly agreed with this statement, whereas 3.1% of female students in Cyprus agreed and another 6.2% of them strongly agreed that 'male students are better at mathematics than female students'. Therefore, the percentage of the female students in England who both agreed and strongly agreed with this

statement was higher than that of female students in Cyprus. This suggests that female students in Cyprus did not perceive male students' abilities in mathematics superior to theirs, and it seems that they had a less stereotypical view of mathematical ability in comparison to female students in England. This could possibly explain why female students in England participate less in mathematics and mathematics-related fields.

(ii) Differences between male students in Cyprus and male students in England

Findings from the questionnaire data showed that there was no statistically significant effect on 'students' confidence in their mathematical abilities' between male students in Cyprus and male students in England. Findings from the interview data, though, suggested that male students in England (6 out of 9) more often than male students in Cyprus (2 out of 6) perceived their abilities in mathematics as strong. It is worth mentioning that findings from the interview data also showed some interesting trends in the way male students in Cyprus and male students in England attributed good performance in mathematics. For example, although both male students in Cyprus and male students in England attributed good performance in mathematics to practice and enjoyment of mathematics, many of the male students in England (3 out of 9) more often than male students in Cyprus (1 out of 6) attributed good performance in mathematics to enjoyment of mathematics. In addition, some of the male students in Cyprus (3 out of 6) attributed good performance in mathematics to natural ability and none of the male students in England did. There was also one male student in Cyprus

who attributed good performance in mathematics to the mathematics teacher. These findings might suggest that male students in England perceived their abilities in mathematics as strong either because they practised or enjoyed mathematics, and not because of their natural abilities.

Findings from the interview data suggested that male students in Cyprus (5 out of 6) more often than male students in England (5 out of 9) were motivated to do well in mathematics in order to get good grades that would allow them to pursue studies at university. On the other hand, male students in England (3 out of 9) more often than male students in Cyprus (1 out of 6), were motivated to do well in mathematics for personal satisfaction. Findings from the questionnaire data on 'students' negative perceptions of their mathematics teacher's expectations' did not show any statistically significant difference between male students in England and Cyprus. Findings from the interview data, however, suggested that male students in Cyprus (3 out of 6) more often than male students in England (2 out of 9) expressed negative feelings about their mathematics teacher. It is worth noting, that findings from the interview data showed that male students in Cyprus expressed negative feelings towards their mathematics teacher at school because of the immense influence of private tutors in Cyprus. Students in Cyprus often felt that because they knew most of the teaching material from their private tutors, their mathematics teacher at school played no role in their learning of mathematics. On the other hand, the male students in England who expressed

negative feelings about their mathematics teacher were because of their mathematics teacher's teaching styles or personality.

Moreover, findings from the questionnaire data showed that male students in England had a less stereotypical view of mathematical ability compared to male students in Cyprus. Findings from the interview data also showed that male students in England (6 out of 9) more often than male students in Cyprus (2 out of 7) perceived girls to be equally good as boys at mathematics. On the other hand, male students in Cyprus (3 out of 6) perceived girls to be good at mathematics because they worked hard, and none of the male students in England did. It is worth noting that although male students in England had a less stereotypical view of mathematical ability it seemed that mathematics was for them an area of strong male significance in a symbolic sense.

8.4.5 How do social factors influence the attitudes of male and female students in Cyprus and England towards mathematics?

Findings from the present study suggested that perceived parental/teacher influence had a positive effect on the attitudes towards mathematics of both male and female students in Cyprus and England. For example, students often referred to their parents helping them with their schoolwork or encouraging them from a young age in learning mathematics by using mathematical activities. In addition, the students often mentioned that their parents valued mathematics and perceived it as important in life, and for that reason, they were expecting them to

do well in it. Students also expressed positive feelings towards their mathematics teacher because of their good ways of teaching (such as working at a good pace with students, making mathematics lessons stimulating, helping students, and setting them homework), and having an interest in students' success in mathematics. Moreover, students referred to their mathematics teacher's expectations of them to do well in mathematics. We can assume that this positive perceived parental/teacher influence on students' mathematical learning had a positive impact on students' attitudes towards mathematics, since the students had a utilitarian view of and an interest in mathematics, and desire to pursue further studies in mathematics-related fields.

It is worth mentioning, that a small number of students in Cyprus and students in England expressed negative feelings towards their mathematics teacher. The students in Cyprus expressed negative feelings towards their school's mathematics teacher because they relied more on their private mathematics tutors and consequently they often felt that their school mathematics teacher played no role in their learning of mathematics. On the other hand, students in England expressed negative feelings towards their mathematics teacher because of his/her teaching styles or personality.

In addition, findings from the study showed that female students in Cyprus had a less stereotypical view of mathematical ability compared to female students in England. The assumption is that female students in Cyprus who are successful in

mathematics and choose mathematics at advanced level do not consider or experience mathematics as a male area as much as female students in England do. It seemed from the interview data that female students in England had strong stereotypical views of mathematical ability perhaps because mathematics for them is an area of strong male significance in a symbolic sense. In fact, students in England referred in their interviews to male students dominating higher-level mathematics, boys and girls having a difference in their brains, boys being naturally good at mathematics and girls being naturally 'more writing people', and girls being good at mathematics because they work hard. Stereotypical views like these could deter girls from taking mathematics further or pursuing mathematics-related careers.

One may think how is it possible for female students in Cyprus who live in a society that can be described as patriarchal to hold less stereotypical views of mathematical ability than the female students in England who live in a more modernised society. As I mentioned in Chapter 3, in recent years Cyprus has changed from being a traditional society to a society that demonstrates many features found in developed western societies in the structure of its economy and in its social and political organization (e.g. Hadjipavlou, 2010). Within the context of this modernizing society, educational choice-making and other social activities take place. Argyrou (1996) argues that during this fast transition to modernity a rather complex combination of elements of both traditional and modern perspectives in the practices of Cypriot families within and between social

classes has emerged. In this social framework, different sections of the Cypriot society approach various social issues in distinctive ways. Argyrou sustains that, in general and as a way of establishing a unique cultural identity, the working classes in Cyprus tend to associate more with traditional ideas, and the middle classes more with modern ones. According to Vryonides (2007) within the traditional perspective, women are seen as being mainly mothers, wives, and supporters of the traditional Cypriot family values of housekeeping and raising children. Conversely, modern views support that women should be considered as individuals with the same potentials and rights in the workplace as men. The students who participated in this study were middle class students. Therefore, if Argyrou's (1996) argument is true and the working classes in Cyprus are associated more with traditional ideas, whereas the middle classes in Cyprus are associated more with modern ideas, then it is not surprising that the female participants of this study who were middle class students did not support stereotypical views of mathematical ability strongly.

8.5 Implications of the study

Findings from this study suggest that stereotypical views of mathematical ability exist between male and female students in Cyprus and England. Children often bring to school strong gender notions from family and society. Therefore, it is the school and teachers' challenge to alter negative ideologies. Myers et al. (2007) suggest that in order to eliminate existing gender roles and stereotyping in schools, teachers and school managers need practical guidance on the legal

context for gender equality and on how to develop an appropriate school climate as well as information on teaching, subject content, and assessment.

Findings from this study also showed that students often valued a teacher who had good ways of teaching (such as working at a good pace with students, making mathematics lessons stimulating, helping students, and setting them homework), and had an interest in their success in mathematics. Both male and female students in Cyprus and England who participated in this study had positive attitudes towards mathematics and often expressed their desire to follow mathematics-related careers. It is likely that these positive attitudes are intimately bound up with good teacher-pupil relations. Therefore, to increase participation in mathematics especially for girls, encouraging teachers who are non-discriminatory towards and respectful of their pupils are needed. This could be achieved through whole-school policies on gender equality, the monitoring of classroom dynamics and levels of attention and support given to pupils.

Moreover, the study showed that both male and female students in Cyprus and England often perceived their parents to encourage them in learning mathematics and expected them to do well in it. It is likely that students' positive attitudes towards mathematics are closely related with perceived positive parental influence in mathematical learning. Therefore, it is important to increase parental encouragement and support in students' mathematical learning maybe

by providing them with information booklets, or involving them in discussions with teachers.

8.6 Recommendations for future research

Findings from this study in line with previous studies suggest that positive parental and teacher influence in students' mathematical learning can have a positive impact on students' attitudes towards mathematics and their decisions to pursue studies in mathematics-related fields. Therefore, solutions to problems of participation in mathematics clearly need to address the influences (i.e. expectations, encouragement, etc.) and attitudes of parents and teachers. For that reason, I recommend that future research to include a larger and more fully representative sample, which includes both parents and teachers and students from a broader range in terms of age, ability, and socioeconomic background.

This study also showed that stereotypical views of mathematical ability were common between students in Cyprus and England. However, female students in Cyprus had a less stereotypical view of mathematical ability compared to female students in England. These views could influence some female students to avoid studies in mathematics-related fields. In order to investigate further the influence of stereotypical views of mathematical ability among mathematics students on the gender imbalance at higher-level mathematics, future studies along the same line as this study would be interesting and important. Studying students' attitudes towards mathematics using quantitative methods is one possible approach, while

a qualitative approach can offer a deeper insight into the relationship between stereotypical views of mathematical ability and gender differences in mathematics participation at higher levels. Both types of investigation are relevant. I also suggest that more international studies are needed taking into account different mathematical cultures and traditions. Although, there is an increasing literature on cross-cultural studies, most of these studies have focused on cross-cultural differences in students' mathematics achievement. Therefore, I suggest that future cross-cultural studies could include comparisons in students' attitudes towards mathematics between different countries.

Lastly, this study showed that the role-modelling and intellectual respect has been transferred in the Cypriot context outside the classroom and to the private tutors. Therefore, students in Cyprus often relied more on their private tutors and they felt that their school mathematics teacher played a limited role in their learning of mathematics. A further in-depth study that could possibly involve school mathematics teachers and private tutors in Cyprus is needed to examine the influence of private tutors that might have produced students' negative feelings and/or perceptions towards their school mathematics teacher, and the relationship between school mathematics teachers and pupils.

Appendix 5A

Male and female students in Cyprus and England

Table 5.1 Male and female students in Cyprus

Male students in Cyprus	Female students in Cyprus
Andreas	Anna
Giannis	Eleni
Giorgos	Irene
Lucas	Maria
Rafael	Polina
Vasilis	

Table 5.2 Male and female students in England

Male students Advanced Level Mathematics	Female students Advanced Level Mathematics	Male students Further Advanced Level Mathematics	Female students Further Advanced Level Mathematics
Chintam	Emilia	Abhilash	Kavita
Kushal	Samia	Bhavik	Rima
Miten	Yasmeen	Joe	Rina
Sam		Shyam	Sneha
Shahzan			

Appendix 5B

English & Greek questionnaire

STUDENTS' ATTITUDES TOWARDS MATHEMATICS

DIRECTIONS: The statements in this survey have to do with your opinions and beliefs about your mathematics class at school and the importance of mathematics in your life. Please read each statement carefully, and circle the number that best expresses your own feelings. By answering these questions I will find out how you feel about yourself and maths. Please note that this is not a test and there are no 'right' or 'wrong' answers. You should also know that all your responses will be kept strictly confidential; no one at your school will see your completed survey or have access to your answers. Please answer all questions.

A) I am a MALE / FEMALE

B) To what extent do you agree or disagree with each of the following statements about mathematics? (Circle only one number on each statement)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
1. I like mathematics.	1	2	3	4	5
2. Mathematics is useful in everyday life.	1	2	3	4	5
3. Doing maths makes me feel nervous or upset.	1	2	3	4	5
4. Mathematics challenges me to use my mind.	1	2	3	4	5
5. I am good at mathematics.	1	2	3	4	5
6. I would like to use mathematics at university.	1	2	3	4	5
7. Mathematics is difficult for me.	1	2	3	4	5
8. Mathematics is dull and boring.	1	2	3	4	5
9. I am able to solve mathematics problems without too much difficulty.	1	2	3	4	5
10. Knowing mathematics will help me get a good job.	1	2	3	4	5
11. I think I could do more advanced mathematics.	1	2	3	4	5
12. Male students are better at maths than female students.	1	2	3	4	5
13. I will use maths less often as an adult.	1	2	3	4	5
14. I do well in mathematics because I work hard.	1	2	3	4	5
15. Female students are as good as male students when solving a maths problem.	1	2	3	4	5
16. I do well in maths because I am naturally good at it.	1	2	3	4	5
17. I would like to avoid using mathematics at university.	1	2	3	4	5
18. It is a matter of luck to get a good mark in maths exams.	1	2	3	4	5

C) To what extent to you agree or disagree with each of the following statements about **your parents expectations from you in mathematics? (Circle only one number on each statement)**

My parents...	Strongly Disagree	Disagree	Neither agree Nor disagree	Agree	Strongly Agree
19. Have been always interested in my progress in maths.	1	2	3	4	5
20. Expect me to do well in mathematics.	1	2	3	4	5
21. Think I need to know only basic maths.	1	2	3	4	5
22. Think is not very important to do well in mathematics.	1	2	3	4	5
23. Think mathematics will help me get a good job.	1	2	3	4	5
24. Think advanced maths is a waste of time for me.	1	2	3	4	5
25. Think I will need maths for my future career.	1	2	3	4	5

D) To what extent to you agree or disagree with each of the following statements **about your mathematics teacher's expectations from you in mathematics? (Circle only one number on each statement)**

My mathematics teacher...	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
26. Believes in my mathematical abilities.	1	2	3	4	5
27. Expects me to do my best at all time in mathematics.	1	2	3	4	5
28. Thinks I am not very good at mathematics.	1	2	3	4	5
29. Thinks I will not need mathematics in my future career.	1	2	3	4	5
30. Thinks it is very important that I do well in mathematics.	1	2	3	4	5
31. Thinks mathematics will help me get a good job.	1	2	3	4	5
32. Thinks it is not very important to do well in mathematics.	1	2	3	4	5

THANK YOU FOR COMPLETING THIS SURVEY

ΟΙ ΣΤΑΣΕΙΣ ΤΩΝ ΜΑΘΗΤΩΝ ΠΡΟΣ ΤΑ ΜΑΘΗΜΑΤΙΚΑ

ΟΔΗΓΙΕΣ: Οι προτάσεις σ' αυτήν την έρευνα έχουν να κάνουν με τις απόψεις και τα πιστεύω σας για το μάθημα των μαθηματικών στο σχολείο σας και την αξία των μαθηματικών στην ζωή σας. Παρακαλώ διαβάστε κάθε πρόταση προσεχτικά και κυκλώστε τον αριθμό που αντιπροσωπεύει καλύτερα αυτό που νιώθετε. Με τις απαντήσεις που θα δώσετε σε αυτές τις ερωτήσεις θα με βοηθήσετε να ανακαλύψω πως νιώθετε για τον εαυτό σας και τα μαθηματικά. Θα ήθελα να υπογραμμίσω ότι αυτό δεν είναι διαγώνισμα και δεν υπάρχουν 'σωστές' ή 'λάθος' απαντήσεις. Πρέπει επίσης να γνωρίζετε ότι οι απαντήσεις που θα δώσετε θα παραμείνουν αυστηρώς εμπιστευτικές. Κανείς από το σχολείο σας δεν θα μπορεί να δει την συμπληρωμένη σας έρευνα και ούτε θα έχει πρόσβαση στις απαντήσεις σας. Παρακαλώ απαντήστε σε όλα τα ερωτήματα.

A) Είμαι..... ΑΓΟΡΙ/ΚΟΡΙΤΣΙ

B) Σε ποιά βαθμό συμφωνείς ή διαφωνείς με κάθε μια από τις ακόλουθες προτάσεις για τα μαθηματικά; (Παρακαλώ κύκλωσε **μόνο ένα αριθμό σε κάθε πρόταση)**

	Διαφωνώ απόλυτα	Διαφωνώ	Ούτε συμφωνώ ούτε διαφωνώ	Συμφωνώ	Συμφωνώ απόλυτα
1.Μου αρέσουν τα μαθηματικά.	1	2	3	4	5
2.Τα μαθηματικά είναι χρήσιμα στην καθημερινή ζωή	1	2	3	4	5
3.Όταν κάνω μαθηματικά νιώθω νευρικότητα και αναστάτωση.	1	2	3	4	5
4.Τα μαθηματικά με παρακινούν να χρησιμοποιώ το μυαλό μου.	1	2	3	4	5
5.Είμαι καλός/ή στα μαθηματικά	1	2	3	4	5
6.Θα ήθελα να χρησιμοποιώ τα μαθηματικά στο πανεπιστήμιο.	1	2	3	4	5
7.Τα μαθηματικά είναι δύσκολα για εμένα.	1	2	3	4	5
8.Τα μαθηματικά είναι ανιαρά και βαρετά.	1	2	3	4	5
9.Είμαι ικανός/ή να λύνω μαθηματικά προβλήματα χωρίς μεγάλη δυσκολία.	1	2	3	4	5
10.Γνωρίζοντας μαθηματικά θα με βοηθήσει να βρώ μια καλή δουλειά.	1	2	3	4	5
11. Νομίζω ότι μπορώ να κάνω περισσότερα ενισχυμένα μαθηματικά.	1	2	3	4	5

12.Οι μαθητές είναι καλύτεροι απ' ότι οι μαθήτριες στα μαθηματικά.	1	2	3	4	5
13. Θα χρησιμοποιώ τα μαθηματικά όχι τόσο συχνά σαν ενήλικας.	1	2	3	4	5
14.Τα πηγαίνω καλά στα μαθηματικά επειδή διαβάζω πολύ.	1	2	3	4	5
15.Οι μαθήτριες είναι τα ίδιο καλές όσο είναι και οι μαθητές όταν λύνουν μαθηματικά προβλήματα.	1	2	3	4	5
16. Τα πηγαίνω καλά στα μαθηματικά επειδή είμαι εκ φύσεως καλός/ή στο μάθημα.	1	2	3	4	5
17.Θα ήθελα να αποφύγω να χρησιμοποιώ μαθηματικά στο πανεπιστήμιο.	1	2	3	4	5
18.Είναι θέμα τύχης αν θα πάρω καλό βαθμό σε εξέταση των μαθηματικών.	1	2	3	4	5

Γ) Σε ποιο βαθμό συμφωνείς ή διαφωνείς με κάθε μια από τις ακόλουθες προτάσεις που αφορούν τις προσδοκίες των γονιών σου από εσενα για τα μαθηματικά; (Κύκλωσε **μόνο** ένα αριθμό σε κάθε πρόταση)

Οι γονείς μου...	Διαφωνώ απόλυτα	Διαφωνώ	Ούτε συμφωνώ ούτε διαφωνώ	Συμφωνώ	Συμφωνώ απόλυτα
19.Παντα ενδιαφέρονταν για την πρόοδο μου στα μαθηματικά.	1	2	3	4	5
20.Περιμένουν από εμένα να τα πηγαίνω καλά στα μαθηματικά.	1	2	3	4	5
21.Πιστεύουν ότι χρειάζεται να ξέρω μόνο τα βασικά μαθηματικά.	1	2	3	4	5
22.Θεωρούν ότι δεν είναι πολύ σημαντικό να τα πηγαίνω καλά στα μαθηματικά.	1	2	3	4	5
23.Πιστεύουν ότι τα μαθηματικά θα με βοηθήσουν να βρώ μια καλή δουλειά.	1	2	3	4	5

24.Πιστεύουν ότι τα ενισχυμένα μαθηματικά είναι χάσιμο χρόνου για εμένα.	1	2	3	4	5
25. Πιστεύουν ότι τα μαθηματικά θα μου χρειαστούν στην μελλοντική μου καριέρα.	1	2	3	4	5

Δ) Σε ποιο βαθμό συμφωνείς ή διαφωνείς με τις ακόλουθες προτάσεις που αφορούν τις προσδοκίες του/της καθηγητή/καθηγήτριας των μαθηματικών από εσένα για τα μαθηματικά; (Κύκλωσε μόνο ένα αριθμό σε κάθε πρόταση)

Ο/η καθηγητής/καθηγήτρια των μαθηματικών...	Διαφωνώ απόλυτα	Διαφωνώ	Ούτε συμφωνώ ούτε διαφωνώ	Συμφωνώ	Συμφωνώ απόλυτα
26.Πιστεύει στις μαθηματικές μου ικανότητες.	1	2	3	4	5
27.Πάντοτε περιμένει να τα πηγαίνω όσο καλά μπορώ στα μαθηματικά.	1	2	3	4	5
28.Πιστεύει πως δεν είμαι αρκετά καλός/ή στα μαθηματικά.	1	2	3	4	5
29.Πιστεύει ότι δεν θα χρειαστώ τα μαθηματικά στην μελλοντική μου καριέρα.	1	2	3	4	5
30.Πιστεύει πως είναι πολύ σημαντικό να τα πάω καλά στα μαθηματικά.	1	2	3	4	5
31. Πιστεύει πως τα μαθηματικά θα με βοηθήσουν να βρώ μια καλή δουλειά.	1	2	3	4	5
32. Θεωρεί ότι δεν είναι πολύ σημαντικό να τα πηγαίνω καλά στα μαθηματικά.	1	2	3	4	5

ΣΑΣ ΕΥΧΑΡΙΣΤΩ ΠΟΥ ΣΥΜΠΛΗΡΩΣΑΤΕ ΑΥΤΗ ΤΗΝ ΕΡΕΥΝΑ

Appendix 5C

Interview Questions

1. Do you think mathematics is important to life?
2. Do you think mathematics is an interesting or a boring subject? And why do you think so?
3. Why did you choose to do advanced mathematics?
4. Do you feel anxious when doing mathematics? For example when solving mathematics problems in the classroom or at home do you feel stressed?
5. How important is it for you to perform well in mathematics?
6. Why do you think you perform well or not well in mathematics?
7. What motivates you to do well in mathematics?
8. How do you perceive your level of ease or difficulty in mathematics? Is mathematics an easy or a difficult subject for you?
9. If mathematics was an easier subject would you have liked it more or less?
10. How confident do you feel about your abilities in mathematics?
Are you able to solve mathematical problems without too much difficulty?
11. How do you feel about your mathematics teacher? Does your mathematics teacher motivate you to do well in mathematics?

12. What are your mathematics teacher's expectations from you? Does your mathematics teacher have any expectations from you?
13. Did your parents motivate you when you were younger to like mathematics? For example did they use any activities involving mathematics to make it interesting for you?
14. Do your parents have any expectations from you in regards to mathematics?
15. Do you think boys are naturally better at mathematics than girls? Or do you think that girls can be as good as boys at mathematics?

Ερωτήσεις Συνέντευξης

1. Πιστεύεις πως τα μαθηματικά είναι σημαντικά στην ζωή μας;
2. Τι πιστεύεις για τα μαθηματικά, είναι ενδιαφέρον ή βαρετό μάθημα; Και γιατί το πιστεύεις αυτό;
3. Γιατί επέλεξες να κάνεις ενισχυμένα μαθηματικά;
4. Το μάθημα των μαθηματικών σου προκαλεί άγχος; Για παράδειγμα όταν λύνεις μαθηματικά προβλήματα στην τάξη ή στο σπίτι νιώθεις κάποια αναστάτωση;
5. Πόσο σημαντικό είναι για εσένα να αποδίδεις καλά στα μαθηματικά;
6. Για ποιο λόγο νομίζεις ότι αποδίδεις καλά/ ή όχι στα μαθηματικά;
7. Ποιό είναι το κίνητρο σου για να τα πηγαίνεις καλά στα μαθηματικά;
8. Πως αντιλαμβάνεσαι τον βαθμό ευκολίας ή δυσκολίας σου στα μαθηματικά;
9. Αν τα μαθηματικά ήταν πιο ευκολό μάθημα θα σου άρεσαν περισσότερο ή λιγότερο;
10. Πόση συγκουριά νιώθεις για τις ικανότητες σου στα μαθηματικά;
Είσαι ικανός/ή να λύνεις μαθηματικά προβλήματα χωρίς μεγάλη δυσκολία;
11. Τι νιώθεις για τον/την καθηγητή/καθηγήτρια των μαθηματικών; Ο καθηγητής/καθηγήτρια σου σε ενθαρύνει να τα πας καλά στα μαθηματικά;
12. Ποιές είναι οι προσδοκίες του/της καθηγητή/καθηγήτριας των μαθηματικών από εσένα;

13. Οι γονείς σου σε είχαν ενθαρρύνει όταν είσουν μικρός/μικρή να σου αρέσουν τα μαθηματικά; Για παράδειγμα χρησιμοποίησαν ποτέ τους κάποιες δραστηριότητες που είχαν σχέση με τα μαθηματικά ούτως ώστε να τα κάνουν πιο ενδιαφέρον για εσένα;
14. Ποίες είναι οι απαιτήσεις τους γονείς σου από εσένα σε σχέση με τα μαθηματικά;
15. Πιστεύεις ότι τα αγόρια είναι εκ φύσεως καλύτερα απ' ότι τα κορίτσια στα μαθηματικά; Ή μήπως νομίζεις ότι τα κορίτσια μπορούν να τα πάνε το ίδιο καλά με τα αγόρια στα μαθηματικά;

Appendix 5D

Letter to the Head of Directorate of Secondary School Teachers in Cyprus,
Ministry of Education

Νατάσσια Χρίστου
Ταχυδρομικό Κιβώτιο 14171,
Ταχυδρομικός τομέας 2154,
Αγγλατζιά, Λευκωσία
e-mail: nc76@le.ac.uk

06/04/2009

Δρ. Ζήνα Πουλλή,
Διευθύντρια Μέσης Εκπαίδευσης,
Υπουργείο Παιδείας και Πολιτισμού,
Διεύθυνση Μέσης Γενικής Εκπαίδευσης,
Γωνία Κίμωνος και Θουκιδίδου,
Ακρόπολη, 1434 Λευκωσία

Αγαπητή Δρ. Πουλλή,

Ονομάζομαι Νατάσσια Χρίστου και φοιτώ στο πανεπιστήμιο του Leicester της Αγγλίας όπου κάνω το διδακτορικό μου στην διδακτική των μαθηματικών. Σας γράφω γιατί χρειάζομαι την άδεια σας για να έχω πρόσβαση σε ένα λύκειο της Κύπρου έτσι ώστε να μπορέσω να κάνω την έρευνα μου. Η έρευνα αυτή έχει σκοπό να συγκρίνει τις στάσεις των Άγγλων και Ελληνο-Κύπριων μαθητών λυκείου (που κάνουν ενισχυμένα μαθηματικά) απέναντι στα μαθηματικά και ταυτόχρονα να κάνει συγκρίσεις μεταξύ των στάσεων απέναντι στα μαθηματικά αγοριών και κοριτσιών από κάθε χώρα και μεταξύ κάθε χώρας.

Για να μπορέσω να μελετήσω τις στάσεις των μαθητών, σκοπεύω να τους δώσω ένα ερωτηματολόγιο και να τους πάρω συνέντευξη. Το ερωτηματολόγιο όπως και η συνέντευξη περιλαμβάνουν ερωτήσεις οι οποίες έχουν σκοπό να εξετάσουν: την αυτοπεποίθηση των μαθητών σε σχέση με την απόδοσή τους στα μαθηματικά, το βαθμό άγχους που προκαλείται από τα μαθηματικά και τις συνέπειες του, τις απόψεις των μαθητών σε σχέση με την αξία των μαθηματικών στην ζωή τους τώρα και στο μέλλον, το βαθμό ευχαρίστησης των μαθητών απέναντι στα μαθηματικά, το ενδιαφέρον των μαθητών στα μαθηματικά και την επιθυμία τους να ακολουθήσουν σπουδές σε σχέση με τα μαθηματικά, τις απόψεις των μαθητών σε σχέση με τις προσδοκίες των γονιών και των δασκάλων τους όσον αφορά τα μαθηματικά, τις απόψεις των μαθητών αν τα

μαθηματικά είναι μάθημα κυρίως για αγόρια ή όχι, και τις αποδόσεις των μαθητών όσον αφορά την επιτυχία ή αποτυχία τους στα μαθηματικά.

Θεωρώ την έρευνα μου αρκετά σημαντική γιατί μέχρι στιγμής δεν υπάρχει κάποια άλλη έρευνα η οποία να συγκρίνει τις στάσεις των μαθητών απέναντι στα μαθηματικά μεταξύ αυτών των δυο χωρών. Οι συγκριτικές έρευνες στον εκπαιδευτικό τομέα είναι αρκετά σημαντικές ούτως ώστε να παρέχουμε στους μαθητές ένα εκπαιδευτικό σύστημα υψηλής ποιότητας. Εκτός από αυτό, υπάρχει δυνατή απόδειξη από άλλους ερευνητές που δείχνει ότι υπάρχει σχέση μεταξύ των στάσεων, της συμμετοχής και της απόδοσης των μαθητών στα μαθηματικά. Επίσης έρευνες έδειξαν ότι τα στερεοτυπικά πιστεύω των κοριτσιών ότι τα μαθηματικά είναι μάθημα κυρίως για αγόρια επιρεάζουν αρνητικά την απόδοσή τους στα μαθηματικά και τις επιλογές τους να πάρουν ενισχυμένα μαθηματικά. Είναι επίσης γνωστό από τις διαπιστώσεις της Τρίτης Διεθνούς Έρευνας των Μαθηματικών που γίνεται κάθε τέσσερα χρόνια ότι υπάρχουν σημαντικές διαφορές μεταξύ Άγγλων και Ελληνο-Κύπριων σε ότι αφορά την απόδοση και τις συμπεριφορές τους στα μαθηματικά.

Οι μαθητές μέσω των συνεντεύξεων που θα τους πάρω θα έχουν την ευκαιρία να περιγράψουν τις εμπειρίες, τις σκέψεις, τις απόψεις τους και τα συναισθήματα τους σε ότι αφορά τα μαθηματικά. Αυτό θα με βοηθήσει να καταλάβω καλύτερα γιατί ορισμένες στάσεις απέναντι στα μαθηματικά δημιουργούνται και αν αυτές οι στάσεις διαφέρουν μεταξύ αγοριών και κοριτσιών στην κάθε χώρα και επίσης αν διαφέρουν μεταξύ μαθητών του ίδιου φύλου από την κάθε χώρα. Θα ήθελα να σημειώσω ότι ούτως ώστε να κάνω την έρευνα μου σύμφωνα με τους κώδικες ηθικής, έχω σκοπό να χρησιμοποιήσω ψευδώνυμα όσον αφορά την ονομασία του σχολείου που θα μελετήσω και τους μαθητές.

Εκτιμώ την βοήθεια σας και περιμένω να λάβω την γραπτή σας συγκατάθεση.

Με εκτίμηση,
Νατάσσια Χρίστου.

Appendix 5E

Official permission of the Head of Directorate of Secondary School Teachers in Cyprus



ΚΥΠΡΙΑΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ
ΠΑΙΔΕΙΑΣ ΚΑΙ ΠΟΛΙΤΙΣΜΟΥ
Αρ. Φακ.: 7.19.46.7/13
Αρ. Τηλ: 22800630/631
Αρ. Φαξ: 22428268
E-mail: circularsec@schools.ac.cy

ΔΙΕΥΘΥΝΣΗ
ΜΕΣΗΣ ΕΚΠΑΙΔΕΥΣΗΣ

15 Μαΐου 2009

Κυρία
Νατάσσια Χρίστου
2154 Αγλαντζιά

Ηλεκτρονική Διεύθυνση: nc76@le.ac.uk

Θέμα: Αίτηση για παραχώρηση άδειας διανομής ερωτηματολογίου και διεξαγωγής συνεντεύξεων με μαθητές Μέσης Εκπαίδευσης, στα πλαίσια διδακτορικών σπουδών στο Πανεπιστήμιο του Leicester με θέμα τη μελέτη των στάσεων και των πεποιθήσεων των μαθητών προς τα Μαθηματικά

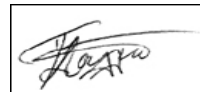
Σε απάντηση επιστολών σας με ημερομηνίες 6 Απριλίου και 28 Απριλίου 2009, σας πληροφορώ ότι το αίτημά σας για διεξαγωγή συνεντεύξεων και διανομή ερωτηματολογίου σε μαθητές ενός δημόσιου λυκείου, εγκρίνεται, νοουμένου ότι θα λάβετε υπόψη τις εισηγήσεις του Κέντρου Εκπαιδευτικής Έρευνας και Αξιολόγησης, οι οποίες σας αποστέλλονται συνημμένα για δική σας ενημέρωση και θα τηρήσετε τις ακόλουθες προϋποθέσεις

1. Θα εξασφαλιστεί η συγκατάθεση του/της Διευθυντή/ντριας του σχολείου,
2. Θα ενημερωθούν εκ των προτέρων οι γονείς/κηδεμόνες για την έρευνα με επιστολή που θα διανεμηθεί στους μαθητές, ώστε σε περίπτωση που δε θα ήθελαν τα παιδιά τους να συμμετάσχουν να έχουν την ευχέρεια να ενημερώσουν σχετικά τη Διεύθυνση του σχολείου,
3. Δε θα επηρεασθεί ο διδακτικός χρόνος για τη συμπλήρωση των ερωτηματολογίων και τη διεξαγωγή συνεντεύξεων,
4. Η συμμετοχή των μαθητών θα είναι προαιρετική,
5. Για τη χρήση μαγνητοφώνου ή οποιασδήποτε άλλης μεθόδου για την καταγραφή των συνεντεύξεων θα πρέπει πρώτα να πάρετε άδεια από τα άτομα τα οποία θα πάρουν μέρος στη συνέντευξη,
6. Θα χειριστείτε τα στοιχεία των μαθητών με τέτοιο τρόπο, ώστε να διασφαλιστεί

7. πλήρως η ανωνυμία τους και
Τα αποτελέσματα της έρευνας θα κοινοποιηθούν στο Υπουργείο Παιδείας και Πολιτισμού.

Παρακαλώ όπως επικοινωνήσετε με τη Διεύθυνση του κάθε σχολείου προκειμένου να καθοριστούν οι λεπτομέρειες.

Ευχόμαστε καλή επιτυχία στους ερευνητικούς σας σκοπούς.



Δρ. Ζήνα Πουλλή
Διευθύντρια Μέσης Εκπαίδευσης

Τίτλος έρευνας:	Οι συμπεριφορές των μαθητών προς τα Μαθηματικά
Ονοματεπώνυμο ερευνητή:	Νατάσσια Χρίστου
Διεύθυνση στην οποία υποβλήθηκε η αίτηση και ημερομηνία υποβολής της:	Διεύθυνση Μέσης Εκπαίδευσης 04/05/2009

1. Εισαγωγή-Αντικείμενο της έρευνας

Σκοπός της έκθεσης αυτής είναι η διατύπωση απόψεων και επισημάνσεων αναφορικά με τα μέσα συλλογής δεδομένων που προβλέπεται να χρησιμοποιηθούν σε προτεινόμενη έρευνα με βάση το αίτημα της κ. Νατάσσας Χρίστου προς τη Διευθύντρια Μέσης Εκπαίδευσης, Δρ. Ζήνα Πουλλή, για παραχώρηση άδειας διενέργειάς της. Το προτεινόμενο ερωτηματολόγιο και το πρωτόκολλο συνέντευξης της έρευνας, η οποία απευθύνεται σε μαθητές Μέσης Εκπαίδευσης της Κύπρου, επιδιώκουν να μελετήσουν τις στάσεις και τις πεποιθήσεις των μαθητών προς τα Μαθηματικά.

2. Επισημάνσεις, απόψεις και εισηγήσεις

Πιο κάτω σημειώνονται και σχολιάζονται επιμέρους πτυχές της ερευνητικής πρότασης που χρήζουν περαιτέρω διευκρινίσεων και προσοχής από μέρους της ερευνήτριας αρχικά σε σχέση με τη *μεθοδολογία* της έρευνας γενικά και ακολούθως σε σχέση με το *επισυναπτόμενο ερωτηματολόγιο* και *πρωτόκολλο συνέντευξης* ειδικότερα.

2.1 Μεθοδολογία

2.1.1 Διαδικασία συλλογής δεδομένων

Πριν από τη διεξαγωγή της έρευνας είναι σημαντικό η ερευνήτρια να ενημερώσει (π.χ. με πληροφοριακό έντυπο) τη διεύθυνση του σχολείου ή των σχολείων που θα συμμετέχουν αναφορικά με το σκοπό της έρευνας, τις τάξεις και τον αριθμό των μαθητών που θα κληθούν να συμμετέχουν, καθώς και για τη διαδικασία και τη χρονική διάρκεια συλλογής των δεδομένων. Όσον αφορά στις συνεντεύξεις, είναι καλό να αποσαφηνιστούν στα σχολεία και τα κριτήρια επιλογής των μαθητών που θα συμμετέχουν σε αυτές, καθώς και ο τρόπος καταγραφής των δεδομένων, π.χ. ηχογράφηση, βιντεογράφηση. Σημειώνεται ωστόσο ότι η επικοινωνία της ερευνήτριας με

τα σχολεία είναι σημαντικό να γίνει μετά την (πιθανή) έγκριση από το Υπουργείο Παιδείας και Πολιτισμού.

2.1.2 Θέματα δεοντολογίας και ηθικής

Στην προτεινόμενη έρευνα τηρούνται βασικές αρχές δεοντολογίας και ηθικής, αφού το ερωτηματολόγιο είναι ανώνυμο και διαβεβαιώνεται επίσης ότι οι απαντήσεις των μαθητών θα τύχουν εμπιστευτικού χειρισμού. Είναι σημαντικό αυτές οι αρχές να τηρηθούν και στην περίπτωση των συνεντεύξεων και να επισημανθούν εκ των προτέρων στους μαθητές που θα συμμετέχουν σε αυτές.

Επιπλέον, επισημαίνουμε ότι είναι καλό η ερευνήτρια να δώσει έντυπο πληροφόρησης (με τα στοιχεία που επισημαίνονται στην παράγραφο 2.1.1) όχι μόνο προς τις διευθύνσεις των σχολείων, αλλά και στους γονείς των μαθητών που θα συμμετέχουν και να εξασφαλίσει τη γραπτή συγκατάθεση των τελευταίων για τη συμμετοχή των παιδιών τους στην έρευνα.

2.2 Μέσα συλλογής δεδομένων

Στην προτεινόμενη έρευνα ως μέσα συλλογής δεδομένων θα χρησιμοποιηθούν το ερωτηματολόγιο και η συνέντευξη. Πιο κάτω παραθέτουμε επισημάνσεις και σχόλια για επιμέρους πτυχές του ερωτηματολογίου και του πρωτόκολλου της συνέντευξης που χρήζουν περαιτέρω προσοχής.

2.2.1 Ερωτηματολόγιο

Το επισυναπτόμενο ερωτηματολόγιο αποτελείται από τέσσερα μέρη. Στο πρώτο μέρος οι μαθητές καλούνται να σημειώσουν το φύλο τους. Το δεύτερο μέρος περιλαμβάνει δηλώσεις που αφορούν στις στάσεις και πεποιθήσεις των μαθητών για τα μαθηματικά και στις πεποιθήσεις επάρκειάς τους σε σχέση με τα μαθηματικά. Το τρίτο μέρος εξετάζει τις απόψεις των μαθητών για τις προσδοκίες των γονιών τους για τους ίδιους σε σχέση με τα μαθηματικά, ενώ το τέταρτο μέρος περιλαμβάνει δηλώσεις που αφορούν στο πώς οι μαθητές αντιλαμβάνονται τις προσδοκίες των εκπαιδευτικών για τους ίδιους αναφορικά με τα μαθηματικά.

Όσον αφορά στο περιεχόμενο του ερωτηματολογίου θεωρούμε ότι οι περισσότερες δηλώσεις είναι κατάλληλες για τους μαθητές και ανταποκρίνονται στο σκοπό της έρευνας. Ο τίτλος του ερωτηματολογίου ωστόσο είναι καλά να τροποποιηθεί ώστε να ανταποκρίνεται στο περιεχόμενό του. Μερικές δηλώσεις περιλαμβάνουν αρνητικές φράσεις (π.χ. 2ν, 4δ, 5γ, 5ζ), γεγονός που πιθανόν να οδηγήσει τους ερωτώμενους στο να δώσουν ανακριβείς απαντήσεις. Εισηγούμαστε αυτές οι δηλώσεις να επαναδιατυπωθούν με καταφατικό τρόπο. Επίσης η δήλωση 2γ θα μπορούσε να διατυπωθεί με λιγότερο απόλυτο τρόπο.

Αναφορικά με την παρουσίαση του ερωτηματολογίου, θεωρούμε ότι η αρίθμηση των δηλώσεων σε κάθε μέρος θα μπορούσε να γίνει με αριθμητικά σύμβολα παρά με γράμματα του αλφαβήτου. Ο διαχωρισμός του ερωτηματολογίου σε μέρη μπορεί να γίνει με πιο ευδιάκριτο τρόπο, π.χ. γράφοντας τίτλους πάνω από κάθε μέρος (Μέρος Α', Μέρος Β', κ.τ.λ.). Στο πρώτο μέρος του ερωτηματολογίου (φύλο) καλό είναι να διατυπωθεί συγκεκριμένη οδηγία συμπλήρωσης, η οποία να κατευθύνει τους μαθητές πώς να απαντήσουν.

Πριν χορηγηθεί το ερωτηματολόγιο, είναι σημαντικό να διαβαστεί (στην ολότητά του: οδηγίες και δηλώσεις) με μεγαλύτερη προσοχή από την ερευνήτρια για τη διόρθωση ορθογραφικών (π.χ. τελικό "ν", τονισμός) και τυπογραφικών λαθών που παρουσιάζονται.

2.2.2 Συνέντευξη

Το περιεχόμενο των ερωτήσεων της συνέντευξης θεωρούμε ότι είναι επίσης κατάλληλο για τους μαθητές. Μερικές από αυτές θα μπορούσαν να διατυπωθούν με διαφορετικό τρόπο ώστε να είναι πιο κατανοητές για τους μαθητές (π.χ. ερωτήσεις 8, 12). Επιπλέον, κάποιες από τις ερωτήσεις (π.χ. ερωτήσεις 4, 13) είναι διατυπωμένες με τρόπο που πιθανόν να προδιαθέτουν τους μαθητές σε σχέση με τις απαντήσεις που θα δώσουν. Εισηγούμαστε να διατυπωθούν με πιο "ουδέτερο" τρόπο, π.χ. ερώτηση 4: Τι συναισθήματα σου δημιουργεί το μάθημα των Μαθηματικών; Τέλος, η διατύπωση κάποιων ερωτήσεων θα μπορούσε να έχει πιο ανοικτό χαρακτήρα (π.χ. ερωτήσεις 1, 9), ώστε να μειωθεί η πιθανή τάση των μαθητών να δίνουν μονολεκτικές απαντήσεις.

Εισήγηση ΚΕΕΑ:

Η έρευνα να προχωρήσει ως έχει για υλοποίηση.

☐

Η έρευνα να προχωρήσει για υλοποίηση, νοούμενου ότι θα γίνουν οι αλλαγές/τροποποιήσεις που επισημαίνονται πιο πάνω

☒

Η αίτηση για έρευνα να υποβληθεί ξανά αφού ληφθούν υπόψη τα πιο πάνω.

☐

Appendix 5F

Letter to the Head teacher and the Head of mathematics of the participating college in England

Natasha Christou
602 De Montfort House,
100 Oxford Street,
Leicester, LE1 5XR
tel. 01162544292
e-mail: nc76@le.ac.uk

.....
.....
.....

Dear Sir,

I am a PhD student supervised by Professor Janet Ainley at the University of Leicester (School of Education). I am writing to you because I would like to undertake a study and I would like to ask for your permission to involve students from your college who take advanced mathematics.

As part of my PhD project I want to administer a questionnaire to all students who take advanced mathematics and also interview 10 students (5 male and 5 female students). The questionnaires can be handed out by the mathematics teacher and I can collect them at a convenient time. Students can be interviewed after they finish their A-level exams. Both the questionnaire and interview, study students' attitudes towards mathematics and involve nine domains which will assess: students' confidence in their mathematical abilities; students' feelings of anxiety; students' perceptions of the usefulness of mathematics in their life now and in the future; students' enjoyment of mathematics; students' motivation; students' perceptions of their parents' expectations with regards to mathematics; students' perceptions of their teachers' expectations with regards to mathematics; students' perceptions of mathematics as a male domain or not; and students' attributions of success or failure in mathematics. The questionnaire takes less than 10 minutes to be answered and students will be given a range of five responses (from strongly disagree to strongly agree) and will be asked to circle one response from each statement of the questionnaire. The interview also takes approximately 15 minutes.

My plan is to make attitudinal comparisons between English and Greek-Cypriot students and find similarities and differences in their attitudes towards mathematics. I will also make gender attitudinal comparisons within each country, across the two countries in order to find possible factors that differentiate male and female students in terms of their

attitudes towards mathematics. There is strong evidence from other researchers to suggest that there is a link between students' attitudes, participation, and achievement in mathematics. Evidence also suggests that male students may be picking up different subtle messages of what is expected of them in the classroom and this may have impacts on their achievement in mathematics and career choices. In addition girls' stereotypical ideas of mathematics as a male domain are negatively correlated with their achievement and with taking advanced mathematics. Based also on findings from the Third International Studies of Mathematics and Science (TIMSS) there are significant differences between English and Greek-Cypriot students' achievement in mathematics and attitudes towards mathematics.

By interviewing students from each country will allow them to describe their experiences, thoughts, beliefs, and feelings about mathematics and will allow me to understand why certain attitudes towards mathematics are formed and find out whether these attitudes are different between students of the opposite gender within countries and whether they are different between students of the same gender between the two countries. At present there is no other study comparing students' attitudes towards mathematics between England and Cyprus. The field of comparative education is very important in order to provide students with an educational system of the highest possible quality. The findings of this study will underscore the importance of positive attitudes towards mathematics and will be useful to mathematics educators, education researchers, and policy makers.

I would like to note that the data obtained from your college will be strictly confidential (this also applies for the Cypriot lyceum involved in the study). The real name of the college and names of participants will not be revealed (I will use pseudonyms instead). This is part of carrying out my study ethically (based on BERA's ethical guidelines). I can also provide you with my CRB if access will be allowed. In addition, I promise to provide you with a report with the findings of my study.

I will appreciate your help and I look forward to hearing from you.

Yours sincerely,
Natasha Christou.

Appendix 5G

Letter to the parents or guardians of the Greek-Cypriot students who participated in the study

Αγαπητοί γονείς,

Διεξάγω μια έρευνα στα μαθηματικά με άδεια του Υπουργείου Παιδείας και Πολιτισμού και της διευθύντριας μέσης εκπαίδευσης Δρ. Ζήνας Πουλλή και θα ήθελα την άδεια σας για να συμπεριλάβω το παιδί σας στην έρευνα αυτή παίρνοντας του μια συνέντευξη περίπου 15 λεπτών. Η συνέντευξη αυτή θα γίνει στον σχολικό χώρο και θα είναι ηχογραφημένη.

Ο σκοπός της έρευνας είναι να μελετήσει τις στάσεις και τις πεποιθήσεις των μαθητών προς στα μαθηματικά ούτως ώστε να υπάρξει καλύτερη κατανόηση όσον αφορά την δημιουργία τους και να δείξει κατά πόσο υπάρχει σχέση μεταξύ των στάσεων και πεποιθήσεων των μαθητών προς τα μαθηματικά και των μελλοντικών επιλογών τους όσον αφορά το μάθημα καθώς επίσης να δείξει κατά πόσο επηρεάζουν την απόδοσης των μαθητών στο μάθημα αυτό.

Θα ήθελα να σημειώσω ότι η συνέντευξη αυτή θα είναι αυστηρώς εμπιστευτική και κανένας (καθηγητής ή μαθητής) εκτός από εμένα δεν θα έχει πρόσβαση στις απαντήσεις των μαθητών.

Εκτιμώ την συνεργασία σας και περιμένω την γραπτή σας συγκατάθεση.

Με εκτίμηση,

Νατάσσια Χρίστου.

APPENDIX 6A

Correlation Matrix

Correlation Matrix (Pearson correlation coefficient and 1-tailed significance of coeff.)

Correl.	Q.1	Q.2	Q.3	Q.4	Q.5	Q.28	Q.29	Q.30	Q.31	Q.32
:1	1.000	.434	-.296	.291	.374	-.256	-.008	.069	.179	-.058
:2	.434	1.000	-.179	.301	.260	-.221	-.085	.217	.300	-.165
:3	-.296	-.179	1.000	-.249	-.247	.208	-.035	-.161	-.086	.140
:4	.291	.301	-.249	1.000	.234	-.234	-.140	.149	.143	-.225
:5	.374	.260	-.247	.234	1.000	-.282	-.117	.094	.062	.015
:6	.389	.353	-.145	.212	.401	-.205	-.295	.057	.141	-.060
:7	-.234	-.109	.238	-.071	-.326	.293	.103	.085	-.082	.066
:8	-.651	-.338	.367	-.286	-.304	.147	.054	-.049	-.085	.067
:9	.118	.215	-.157	.095	.563	-.221	-.101	.319	.230	.008
:10	.314	.426	-.194	.402	.083	-.223	-.104	.173	.435	-.145
:11	.451	.243	-.216	.178	.425	-.249	-.077	.019	.121	-.056
:12	.059	-.046	.069	.010	.044	-.015	-.024	.060	-.127	.019
:13	-.360	-.327	.070	-.184	-.169	.077	.104	-.229	-.267	.117
:14	.065	.092	-.077	.020	.146	-.144	.073	-.050	-.003	.155
:15	-.047	-.070	-.202	.181	-.146	-.055	.039	-.047	.000	.002
:16	.305	.203	-.195	.191	.533	-.252	-.121	.216	.202	-.011
:17	-.420	-.326	.229	-.171	-.334	.228	.238	-.082	-.078	.122
:18	-.225	-.100	.345	-.300	-.064	.275	.183	-.014	-.054	.216
:19	.212	.258	-.068	.225	.148	-.031	-.054	.090	.239	-.048
:20	.233	.309	-.144	.271	.270	-.239	-.013	.065	.173	-.098
:21	-.180	-.201	.175	-.199	-.162	.057	.072	-.025	-.184	.172
:22	-.101	-.230	.210	-.326	-.141	.103	.060	-.076	-.249	.191
:23	.204	.371	-.075	.356	.195	-.088	-.038	.108	.340	-.150
:24	-.157	-.287	.101	-.245	-.177	.455	.478	.095	-.034	.508
Q25	.158	.350	-.088	.216	.186	.003	.000	.268	.479	.033
Q26	.314	.278	-.249	.229	.249	-.272	-.010	.449	.428	.023
Q27	.331	.355	-.274	.351	.229	-.133	-.004	.484	.510	-.110
Q28	-.256	-.221	.208	-.234	-.282	1.000	.462	.042	-.024	.491
Q29	-.008	-.085	-.035	-.140	-.117	.462	1.000	-.066	-.141	.544
Q30	.069	.217	-.161	.149	.094	.042	-.066	1.000	.599	-.113
Q31	.179	.300	-.086	.143	.062	-.024	-.141	.599	1.000	-.156
Q32	-.058	-.165	.140	-.225	.015	.491	.544	-.113	-.156	1.000

Sig. (1-tailed)

:1	.000	.000	.000	.000	.000	.001	.458	.192	.012	.230
:2	.000	.011	.011	.000	.000	.002	.142	.003	.000	.018
:3	.000	.000	.001	.001	.001	.004	.329	.020	.139	.037
:4	.000	.000	.001	.001	.001	.001	.038	.030	.035	.002
:5	.000	.000	.032	.003	.000	.000	.070	.116	.218	.423
:6	.001	.083	.001	.184	.000	.004	.000	.234	.037	.223
:7	.000	.000	.000	.000	.000	.000	.095	.140	.151	.203
:8	.067	.003	.023	.115	.000	.031	.248	.268	.141	.197
:9	.000	.000	.007	.000	.146	.002	.101	.000	.002	.459
:10	.000	.001	.003	.012	.000	.002	.094	.014	.000	.033
Q11	.227	.279	.191	.449	.288	.001	.166	.408	.063	.238
Q12	.000	.000	.187	.010	.016	.423	.383	.225	.053	.406
Q13	.206	.122	.166	.401	.032	.165	.093	.002	.000	.069
Q14	.278	.187	.005	.011	.032	.033	.177	.265	.487	.025
Q15	.000	.005	.006	.008	.000	.245	.313	.276	.498	.491
Q16	.000	.000	.002	.015	.000	.001	.062	.003	.005	.443
Q17	.002	.102	.000	.000	.211	.002	.001	.150	.162	.061
Q18	.003	.000	.196	.002	.030	.000	.010	.429	.247	.003
Q19	.001	.000	.034	.000	.000	.345	.247	.127	.001	.271
Q20	.011	.005	.013	.006	.020	.001	.437	.207	.014	.107
Q21	.100	.002	.004	.000	.037	.236	.181	.378	.009	.014
Q22	.005	.000	.170	.000	.006	.097	.223	.169	.001	.008
Q23	.023	.000	.101	.001	.012	.133	.316	.086	.000	.028
Q24	.022	.000	.134	.003	.009	.000	.000	.115	.333	.000
Q25	.000	.000	.001	.002	.001	.483	.499	.000	.000	.338
Q26	.000	.000	.000	.000	.002	.000	.451	.000	.000	.385
Q27	.001	.002	.004	.001	.000	.045	.479	.000	.000	.082
Q29	.458	.142	.329	.038	.070	.000	.000	.296	.379	.000
Q30	.192	.003	.020	.030	.116	.296	.203	.203	.037	.000
Q31	.012	.000	.139	.035	.218	.379	.037	.000	.000	.075
Q32	.230	.018	.037	.002	.423	.000	.000	.075	.024	.024

Determinant = 7.37E-007

This table shows the *R*-matrix (or correlation matrix). The top half of this table contains the Pearson correlation coefficient between all pairs of questions whereas the bottom half contains the one-tailed significance of these coefficients. In order to do a Factor

Analysis we need to have variables that correlate fairly well, but not perfectly. Also any variables that correlate with no others should be eliminated. Therefore, this correlation matrix is used to check the pattern of relationships. This is done by scanning the significance values and looking for any variable for which the majority of values are greater than .05. Then we scan the correlation coefficients themselves and look for any greater than .9. Thankfully, in this table there are no correlation coefficients greater than .9, therefore no problem will arise with our data (i.e. singularity in the data). Looking at the determinant of the correlation matrix listed at the bottom of the matrix, we can see that its value is 7.37E-007 (which is .000000737) which is greater than .0000001. So we can be confident that multicollinearity is not a problem for our data.

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