Investigating influences on the choice of Mathematics at GCE A-level: a gender perspective

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A thesis submitted in partial fulfilment of the requirement for the degree:

Doctorate of Education (EdD)

The University of Sheffield

School of Education

September, 2015

Abstract

This research investigates influences on student choice of Mathematics at General Certificate of Education (GCE) Advanced Level (A-level) from a gender perspective. One of the main aims of this study is to investigate the reasons why fewer girls than boys chose to study A-level Mathematics between 2005 and 2011 in the UK. The theoretical perspective of this study is the General Model of Academic Choice (Eccles, 2011). This model helped to make links between my analysis and existing concepts relating to gender, choice and performance in Mathematics. Three main kinds of data were collected and analysed in this case study involving three schools: face-to-face interviews with students and teachers, self-completed questionnaires with students, and the published examination results of the Joint Council for Qualifications (JCQ), in the UK.

The study found that although proportionately more girls than boys attained grades A*-B at General Certificate of Secondary Education (GCSE) level 2005-2011, within the same period, more boys than girls chose A-level Mathematics. This is important because courses in which either males or females at GCSE level performed well, demonstrated a correspondingly higher rate of participation for the same gender in the same or similar courses at GCE A-level, with Mathematics being the exception. Evidence in my study suggests that improving girls' confidence, positive attitudes and perceptions towards Mathematics could encourage girls' participation in A-level Mathematics; but more importantly girls are more likely to continue to study Mathematics if their previous good performance is a direct effect of their enjoyment of Mathematics. Early engagement of girls with algebra can enhance confidence, positive attitude and perception of Mathematics, build a strong foundation in algebra and may subsequently increase their participation in A-level Mathematics. Finally, gender equity in Mathematics education should not only be about attaining equal outcomes, but should work towards the elimination of obstacles inhibiting equal participation. I therefore propose that gender equity in Mathematics education should lead to less disparity in both performance and participation.

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Acknowledgements

I am very grateful to my supervisor, Dr Chris Winter, for her unwavering support and comments. I am also grateful to my wife Phyllis and my children Abena, Kwame and Naana Owusu-Amoah for their backing and encouragement throughout the whole period of my studies.

CHAPTER ONE: Introduction

The purpose of this first chapter is to give the context and aims of the study: a preview of the significance of the study, the problem, policy context, research questions and methodology and methods of the research. This chapter also examines the researcher's positionality and how the research as a whole has been structured. The focus of the study is to investigate the factors influencing student choice of Mathematics as a subject of study at the General Certificate of Education (GCE) Advanced Level (A-level) from a gender perspective. As part of my study, I analysed the statistical data of both General Certificate of Secondary Education (GCSE) and A-level examination results from June 2005 to June 2011 published by the Joint Council for Qualifications (JCQ). For this reason, some of the references relating to the situation in Mathematics education refer to the mid-2000s. The JCQ is an organisation comprising of the seven main examining boards in the UK. As part of the work, the JCQ publishes the integrated version of GCSE and A-level results of member examining boards (JCQ, 2015).

In 2006, a report by the National Mathematics Panel (NMP) on proficiency in Mathematics stated that Mathematics is increasingly becoming the primary key to economic success for individuals and for nations (NMP, 2006). The NMP further argued that technological advancement has brought with it the need for more people to pursue further studies in Mathematics. Mathematics is strongly represented in the design of computer games and in the Economics and Physics curricula in Higher Education (HE) (NMP, 2006). In a report by Deloitte (2012) on measuring the economic benefits of Mathematical Science research in the UK, it was stated that the application of Mathematics can be seen everywhere ranging from electronic devices, predicting the weather and the successful organisation of the London 2012 Olympic games.

Given that Mathematics has already become an integral part of the economies of many countries, discrepancies in gender participation in Mathematics education at A-level in the UK cannot be of benefit to the nation. In a Canadian study, Beaton et al. (2007), found that despite more females (62%) than males studying pre-Higher Education (HE) Mathematics, the number of women opting for Mathematics and Mathematics-intensive programmes such as Engineering and Physics at university level is fewer than men. Mathematics is a major part of the Science, Technology, Engineering and Mathematics (STEM) courses. In the evidence based on the 2009 entry figures for UK GCSE examinations, Kirkup et al. (2010) found that girls accounted for 48% of student entries for GCSE STEM courses. At A-level, they accounted for 42% of the students studying STEM courses. Unlike Canada, where girls are in the majority for STEM subjects at pre-HE but in the minority in higher education, in the UK girls are in the minority at both pre-HE and higher education. Several factors have been suggested to influence pupils' choice of subjects, including influences from peers, parents, teachers, and the media (The Department for Education and Skills (DfES), 2008). Awan et al. (2011) found that if a girl has a positive perception (self-concept) of herself, it has a great effect on her achievement in Mathematics. Awan et al. (2011) also revealed that as a girl grows up, her self-concept in relation to Mathematics is influenced by others' perceptions of her (i.e. how others see her), whereas in boys, this effect is absent. Sources of self-concept include parents, peers and teachers (Tomasetto et al., 2011). For example, in the United States, Lindberg et al. (2010) found parity in the performances of males and females in Mathematics. Despite this parity, Tomasetto et al. (2011) found that more mothers than fathers continued to endorse gender stereotypes towards Mathematics to the detriment of their daughters. These perceptions have the tendency to affect a girl's interest in Mathematics as she grows up (Leaper et. al., 2012). Between 2005 and 2007, the DfES (2008) found parity in examination performance between male and female students at both GCSE and A-level Mathematics in the UK; however, the number of girls studying A-level Mathematics remains fewer than boys (FMSP, 2014). This study seeks to investigate these differences in students' participation in A-level Mathematics, by investigating the factors contributing to the relatively fewer number of girls than boys studying Mathematics at A-level in the UK. The importance of investigating why this relative difference in participation in A-level Mathematics exists is discussed under the section headed "The significance of the study". The background of the study, as explained above, has led to the following aims.

Aims of the Study

The aims of the study are to investigate:

1. Gender differences in performances of students in GCSE Mathematics

2. Gender differences in participation in A-level Mathematics

3. Factors influencing the choice of Mathematics at A-level

4. Teachers' and students' perception of gender and the choice of Mathematics at A-level.

The Significance of the Study

In an inquiry into post-14 Mathematics education conducted on behalf of the Qualification and Curriculum Authority (QCA) (Smith, 2005), the report states the importance of Mathematics at post-16) to the economy and to the modern society (QCA, 2005). The report found that there was a general decline in students studying A-level Mathematics, from 24% in 2001 to 17% in 2005. This is worrying, especially when the same report states that the supply and demand of people with STEM skills is one of the strategic priorities of the UK Government for increasing innovation and productivity (DfES, 2004). Knowing that there is a decrease in the number of young people studying Mathematics beyond age 16 is a positive step, but finding out what has led to this decline is equally important.

In the UK, the DfES (2008) observed that there was no significant difference in the performance and entry figures of boys and girls in GCSE Mathematics from 2005 to 2007. One would have expected this equivalence to be reflected in the number of girls studying A-level Mathematics. Unfortunately this is not the case, as Smith's (QCA, 2005) report found that from 1999 to 2004, only 38% of the students who studied A-level Mathematics were female. In a follow-up to Smith's (2005) report in 2007, the QCA (2007) found that in 2006, there was an increase of 18.6% in the number of students studying A-level Mathematics (QCA, 2007). Out of the total number of A-level Mathematics students in that same year (2006), 62.2% were male and the rest were female. It is good news to know that in 2006 there was an 18.6% increase in A-level Mathematics participation, but unfortunately, girls formed only 37.8% of the participants. It is therefore important to know why fewer girls than boys are studying A-level Mathematics. Finding the reasons behind this difference is one of the aims of this study investigating the factors influencing students' choice of Mathematics at A-level.

Reynan and Brainerda (2007) in a study of the importance of Mathematics in healthcare and human judgement, found that despite an increase in the demand for mathematical and technical ability in those entering the labour market, a lot of Americans are unprepared to meet these challenges by studying Mathematics. They therefore see patient-centred decision making as an unlikely objective for patients who cannot make basic judgments about health-related possibilities and risks. This makes it difficult for patients to arrive at a decision based on inference or mathematical deductions of the problems at stake. This is more important when the responsibility of making sense of information is shifting from health personnel to patients to make their own choices of healthcare. Reyna and Brainerda (2007) conclude that numeracy alone is not enough to meet the mathematical demands of this century, but continuous studies in Mathematics at a higher level are required.

Beede et al. (2011) in their research on women in STEM and wages in the United States (US), found that STEM qualifications play a major part in wage determination for professionals and highly skilled workers. In general, men are remunerated better than their female colleagues in equivalent job descriptions across various levels of education and occupational groupings (Beede et al., 2011). There is however no significant gender wage difference among professionals with higher level skills in Mathematics (Mitra, 2002). In the study, Beede et al. (2011) found that women with STEM degrees earn 33% more than graduate women without STEM degrees. Beede et al. (2011) take a similar view to Mitra (2002), who suggested that girls could be motivated to improve their quantitative skills through prioritising courses in higher level Mathematics as a way of bridging the gender pay gap. The overwhelming and growing importance of Mathematics in this computerised age makes this study very relevant at this time. I would argue that efforts should be made to address the obstacles holding girls back from studying Mathematics at A-level.

In summary, the growing importance of Mathematics to our social and economic lives has given rise to the demand for both males and females not only to study Mathematics to GCSE level, but also beyond. The demands for mathematically-literate employees could be met if the learning or pursuit of a career in Mathematics or Mathematics-related subjects was disassociated from the idea of it being a “male” subject. My choice of the A-level qualification specifically as the focus of this study has been influenced by the fact that A-level or equivalent qualifications form a major part of the entry requirements for undergraduate programmes in UK universities UK (Universities and Colleges Admissions Service (UCAS), 2013). Encouraging A-level Mathematics participation could lead to an increase in interest in undergraduate programmes in Mathematics or Mathematics-related careers.

The Problem

In order to begin to identify, understand and address gender-based differences in the performance and participation of students in school Mathematics, it would be appropriate to compare students’ performance and entry figures in Mathematics with other subjects at both GCSE and A-level on a gender basis. This is to help establish whether any differences in performance and participation by gender are peculiar to Mathematics or not. Based on this premise, this section examines subjects studied at both GCSE and A-level in the UK. This section therefore involves comparing the gender-based results and entry figures of subjects in the Arts (Geography, History, and Drama); Sciences (Physics, Chemistry, Biology and Dual Science) and English (English Language and Literature) with Mathematics at GCSE and/or A-level. The choice of these subjects was based on the fact that they can be taken at both GCSE and A-level in the UK.

This section is a critical review of the GCSE results from 2001 to 2003; whereas the A-level data is based on 2003 to 2005 results. The reason for restricting this critical review to these dates is because the detailed analysis of 2005 to 2011 has been done in Chapter 4. The first assumption made here is that since on average the A-level takes two years in UK, the majority of the 2001 GCSE students are likely to be the A-level students who completed in 2003. Similarly, the 2003 GCSE students could correspond with 2005 A-level students. The second assumption, derived from a sample of sixth form schools' prospectuses, is that the minimum entry requirement for the selected subjects is grade B at GCSE level. Table 1 was therefore derived from the Joint Council for Qualifications (JCQ) results and was based on the two assumptions stated above. The calculations of the percentages were therefore based on the total number of students who achieved A*-B grades in the subjects concerned. From Table 1, in 2001 for example, 54.2% of the male students achieved A*-B grades compared to 45.8% of the female students.

Table 1: Percentage by gender of GCSE students with grade A*- B (2001-2003)

	Percentage by gender of students with grade A*-B					
Subjects	**2001**		**2002**		**2003**	
	Male	Female	Male	Female	Male	Female
Geography	54.2	45.8	50.8	49.2	50.8	49.2
History	48.6	51.4	46.4	53.6	46.8	53.2
Drama	31.6	68.4	29.0	71.0	27.9	72.1
Physics	60.7	39.3	60.4	39.6	61.0	39.0
Chemistry	59.6	40.4	57.4	42.6	58.5	41.5
Biology	59.5	40.5	56.3	43.7	57.2	42.8
Dual Science	40.1	59.9	46.4	53.6	46.6	53.4
English	42.3	57.7	40.6	59.4	40.5	59.5
English Literature	41.3	58.7	39.9	60.1	40.2	59.8
Mathematics	48.2	51.8	49.1	50.9	48.5	51.5

(Source: JCQ, 2010)

Table 2 shows the percentage by gender of students who took part in A-level examinations in the following subjects; Geography, History, Expressive Arts/Drama, Physics, Chemistry, Biology, English and Mathematics. Table 2 is based on the entry figures of the various subjects, but not on performance. The relevance of this to the main study is to establish whether performance in various subjects at GCSE level is a factor in the choice of subjects selected at A-level.

Table 2: Students who sat for A-level examinations by gender (2003-2005)

	Percentage of Students who sat for A-level examinations by gender					
	2003		2004		2005	
	Male	Female	Male	female	Male	Female
Geography	54.0	46.0	54.8	45.2	54.1	45.9
History	48.7	51.3	49.8	50.2	49.5	50.5
Expressive Arts/Drama	26.1	73.9	26.8	73.2	27.7	72.3
Physics	77.2	22.8	77.7	22.3	78.0	22.0
Chemistry	48.5	51.5	49.2	50.8	50.6	49.4
Biology	38.6	61.4	39.7	60.3	40.9	59.1
English	29.6	70.4	30.3	69.7	30.7	69.3
Mathematics	63.0	37.0	61.3	38.7	61.9	38.1

(Source: JCQ, 2010)

Comparing Table 1 with Table 2, among the Arts subjects (Geography, History, Drama) the pass rate at GCSE on a gender basis reflects the proportional representation of males and females at A-level. In Table 1 (2001), for grades

A*-B in Drama, 68.4% were female and 31.6% were male. This is an indication that more female students obtained grades A*-B than male students. This is also reflected in the number of students who took Expressive Arts/Drama at A-level. In 2003 (Table 2), 73.9% of the students who completed the course in Expressive Arts/Drama were female compared to 26.1% male. Similar trends were also observed with English and English Literature, where as a result of more females than males obtaining A*-B at GCSE level (Table 1) the proportion of females taking English at A-level is also higher than males (Table 2).

In the Sciences, students offered the Dual Science award at GCSE (In the UK, this is a combined study of GCSE Physics, Chemistry and Biology that leads to the award of two GCSE grades) and acquiring the required grades (A*-B) to study A-level Sciences, have the option to choose all or any of the three Science subjects (Physics, Chemistry, Biology) at A-level. From Table 1, the results of Physics, Chemistry and Biology show that more boys than girls achieved grades A*-B, but in Dual Science awards, more girls than boys achieved grades A*-B. Whereas the higher pass rates for boys at GCSE Physics is reflected by a higher proportional representation of boys than girls in A-level Physics, the same cannot be said of Chemistry and Biology (Table 2). The A-level entry figures seem to suggest that most of the girls who performed well in Dual Science at GCSE level chose Biology at A-level. Chemistry at A-level also attracted more girls from the students who were offered Dual Science than Physics. A possible explanation for this trend is suggested by Ceci and Williams (2010), who explain that Mathematics-intensive subjects tend to attract fewer females than non-Mathematics-intensive subjects. Physics is perceived to be a more Mathematics-intensive subject than Chemistry. Similarly, Chemistry is also perceived to be more Mathematics-intensive than Biology (Barmby and Defty, 2006).

Contrary to the trends discussed above, the statistical data for Mathematics in Table 1 at GCSE level shows that the number of girls who qualified to study A-level Mathematics was higher than the number of boys. Despite this, more boys than girls chose to study A-level Mathematics (Table 2).

The above comparison between GCSE performance (Table 1) and A-level participation (Table 2) shows that where more girls than boys achieve well in the subject at GCSE there is a relative proportional gender representation of the subject at A-level. This means that where more girls achieve highly at GCSE than boys, at A-level, more girls than boys will opt for the subject and vice-versa. The exception to this pattern is however the case of Mathematics. In GCSE Mathematics, more girls than boys achieved grades A*-B, but fewer girls than boys went on to study A-level Mathematics.

In conclusion, gender-based differences in participation at A-level seem to be biased towards females in subjects that are perceived to be less Mathematics-intensive and biased towards males in highly Mathematics-intensive subjects. The trends identified above, in which higher grades in one gender group at GCSE seem to be linked to higher gender participation in the same group at A-level, seem to suggest that the performance of students in subjects at GCSE may influence the choice of similar subjects at A-level. In Mathematics however, comparison between Tables 1 and 2, shows that the issue of girls being underrepresented in Mathematics and Mathematics-related subjects goes beyond just performance. This is because despite the table showing the number of girls obtaining A*-B grades at GCSE being higher than boys, fewer girls than boys studied A-level Mathematics. The aim of the study is to investigate, from a gender perspective, the factors influencing the choice of Mathematics at A-level. It is therefore important to analyse the extent to which previous performance and other factors influence the choice of subjects at A-level. I discuss the literature on gender and choice of school subjects further in the literature review (Chapter 2).

Policy Context

The Equality Act 2006 came into force in 2006 in England; 2007 in Scotland and 2008 in Wales (Centre for Studies on Inclusive Education (CSIE), 2013). The Equality Act (2006) is an amendment of the Sex Discrimination Act (CSIE, 2013). The two main aims of the Act are to:

i. eliminate unlawful discrimination and harassment and

ii. Promote equal opportunity between males and females.

In this Act, there are gender equality duties, which public authorities including schools have a statutory duty to promote among males and females. Schools are therefore required to prepare and maintain a Gender Equality Scheme. The Gender Equality Scheme is a document prepared by institutions to spell out clearly how gender equality is to be promoted and achieved in each individual institution (The Commission for Equality and Human Rights, 2006).

The Equality Act 2006 seeks to establish equity among males and females, but within it there are many issues needing to be addressed in order to achieve the desired impact. For example, gender inequalities in the uptake of school subjects are included in this list of issues. The Equality Act 2006 therefore forms the overarching policy context in which this study is situated, with the view of establishing equity in participation and performance in Mathematics irrespective of gender.

Research Questions

The research questions for this study serve as the focus of the investigation (Robson, 2011). In arriving at these questions, efforts have been made to ensure that the questions are feasible, clear, significant and ethical (Fraenkel and Wallen, 2008). In this case, the research questions have been posed to serve as a guide in investigating the problem. The focus of this study is therefore based on the following questions:

1. Are there any differences in examination performance in Mathematics between boys and girls at GCSE?

2. Are there any differences in the number of boys and girls studying A-level Mathematics?

3. What factors influence the choice of Mathematics at A-level?

4. What are Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level?

5. What are students' perspectives about gender and the choice of Mathematics at A-level?

The above research questions have served as the guide to focusing the conduct of the study. In investigating factors influencing the choice of A-level Mathematics, there is a need to identify gender differences in performance in GCSE Mathematics and any differences in participation in A-level Mathematics, because one of the aims of the study is to investigate the participation of students in A-level Mathematics by gender. Secondly, unlike A-level subjects such as Drama, Psychology and Philosophy, where students do not necessarily require previous performance in the same subjects at GCSE level before they are allowed to study them, the ability to study Mathematics at A-level depends on previous performance in Mathematics at GCSE level (Rushton and Wilson, 2014). The emphases in this study are on the proportions of girls and boys who study A-level Mathematics and the factors that influence the choice to study A-level Mathematics or not. Research Questions 1, 2 and 3 are therefore important as guides in addressing these aims of the study. Research Questions 4 and 5 provide direction in addressing the other aims of the study; to identify students and teachers' perceptions of gender and the choice of Mathematics. The motive for asking these questions is to establish how these perceptions can influence students' choices of subjects to study. Detailed reasons for the choice of the five research questions have been stated in Chapter 3.

Methodology and Methods

A research method is the technique and process of gathering data (Robson, 2011). The aim of research methodology is to describe and analyse these methods while emphasising their advantages and limitations. Methodology also involves explaining precautions and consequences. The selection of the methods used in this research was driven by the aims of the investigation; the research questions; the literature and the time and resources at my disposal (Robson, 2011).

Data for this study were obtained through primary and secondary sources. The secondary data source is quantitative (GCSE and A-level examinations results published by the Joint Council for Qualifications (JCQ) from June 2005 to June 2011). The primary data sources were interviews and self-completed questionnaires. I justify my choices of these approaches to gathering data in the methodology chapter to follow (Chapter 3). A key influence on my choice of methodology and methods is my positionality as researcher.

Positionality

The researcher’s background in terms of their philosophical position and fundamental assumptions is described as the positionality of the researcher (Opie and Sikes, 2004). Opie and Sikes (2004) see this as the most significant factor influencing the choice and use of methodology and procedures for the research. Positionality takes into consideration the researcher's values and beliefs (Opie and Sikes, 2004). These values and beliefs may have their roots in factors such as religious faith, experience, historical and geographical location. Based on these views on positionality, I will give a brief background about myself and how my background may have influenced the research decisions made in connection with this study.

My primary education was in a co-educational school, but my secondary education was in a boys’ (single-sex) boarding school. The first year of my middle school education was in a boys-only school, with later years spent in a co-educational middle school. As a teacher, I have taught in both boys-only schools and co-educational schools. I started teaching Mathematics and Physics in a secondary school as a non-professional teacher in Ghana after Sixth form and National Service. I later went to university and pursued an undergraduate programme in Engineering. After graduating, I continued teaching Mathematics in another secondary school, after which I joined an examining board. These experiences may have influenced the research decisions I have made in respect of this study. For example, during my first experience as a teacher where I taught in a co-educational school, I noticed that the majority of boys who came to secondary school with strong previous performance in Mathematics continued to excel in Mathematics. Boys whose previous performance in Mathematics had not been strong also managed to improve later. In my experience, this was not the case with girls in co-educational schools. The number of bright girls in Mathematics declined as the years went by. My second experience in teaching was in a boys-only secondary school. At the boys-only school, my perceptions of the boys were similar to boys in co-educational schools, where boys who started secondary education with high interest in Mathematics were able to sustain that interest throughout their course of study. Others who had displayed less interest at the initial stage also became more interested in the subject in later years. It is clear that this account is anecdotal and not founded on rigorous research. However as an experience, it forms a “hunch” that I wish to pursue through this study. I have not had the experience of teaching in a single-sex girls’ school and therefore cannot present any relevant information in that respect.

I grew up in a family where my parents had strong views about equity between males and females. I therefore grew up learning to do any work, with little consideration of gender connotations. My parents may have instilled in me the idea of equity between males and females and this may have influenced my choice of a topic in which gender equity plays a key role.

My past experience with single-sex boys-only schools and co-educational schools, coupled with my upbringing, may have influenced my interest in gender equity in Mathematics participation and achievement. I have been involved with secondary schools’ assessment for more than ten years in both formative and summative stages. My experience of working for an examining board, where I had access to the final examination results of secondary school students, may also have had a strong impact on my choice of topic. Through my access to this information, I developed an interest in comparing the performances of male and female students when the final results were published. My strong science background may have influenced my choices of quantitative secondary data and quantitative analysis as a method of data interpretation.

In summary, my social and cultural upbringing, educational development, personal reflections and my interest in the teaching of Mathematics as well as my involvement in educational assessment over the years have influenced my decision as to the choice of this study. My involvement with educational assessment and my strong science background have also affected my choice of quantitative analysis to interpret data. Access to informants in this study was made possible because of my position as a Mathematics teacher at the time of the research. This thesis has been structured to address the study aims and research questions according to the summary below.

Structure of the thesis

The thesis is made up of seven chapters. In Chapter 2, I present the critical literature review and the theoretical framework of the study. The literature review is in three parts: to determine whether similar studies already exist; to obtain guidance from existing research for this investigation and to find out if there are any points of departure from some of the existing literature (Robson, 2011). In Chapter 2, I review various theories associated with gender and learning Mathematics, such as the social construction of gender, the concept of gender in education, performativity and the social reproduction of gender, as well as how these are related to the influences of neo-liberalism on Mathematics education. The chapter examines the relevance of gender theories in the choices students make in studying Mathematics. Perception and attitude have been identified as contributing factors to the debate on students' performance in Mathematics (Leaper et. al., 2012). It is from this view that Chapter 2 examines students' perceptions, attitudes and other social factors around learning Mathematics.

Chapter 3 takes a critical look at the methods used to address the research questions. The chapter begins by examining the methods used in the research from the perspective of different researchers. The study made use of both primary and secondary data. The collection of primary data involved face-to-face interviews and self-completed questionnaires as the main tools. The secondary data is obtained from past results of GCSE and A-level examinations published by the Joint Council for Qualifications (JCQ).

Chapter 4 focuses on the analysis and discussion of the secondary data of the GCSE and A-level past results published by the JCQ. This analysis focuses first on GCSE examination results in Mathematics and additional Mathematics in the UK before analysing the examination results of A-level Mathematics of UK students.

Chapter 5 focuses on the analysis of the interview data. The analysis focuses on a sample of students and teachers in three schools, who took part in the study by completing questionnaires and in-depth-interviews. The main approach for analysing the primary data from the schools is based on Thematic Coding Analysis (Silverman, 2011).

Chapter 6 discusses the analysis in Chapters 4 and 5. This chapter addresses each of the research questions and reveals ways in which the study agrees with or challenges the existing research referred to in the literature review. This discussion chapter relates the analysis to Chapter 2 by linking it with the social construction and reproduction of gender, performativity, and government gender policy in relation to Mathematics education. Attempts have also been made to relate the study findings to the general theoretical framework on gender and Mathematics.

Chapter 7 summarises the findings and concludes the study. The chapter presents recommendations for further research, policy and practice; the overall limitations of the study and the lessons I learnt on my journey as a researcher. On the basis of the study's findings, I make recommendations for implementation by policymakers and stakeholders in education.

This first chapter has been used to introduce the background, the aims of the study, the research questions and the research methodology and methods. The chapter has also given a summary of my positionality as a researcher and how my background and presuppositions may have influenced some of the choices in the study. Finally, the chapter has given an overview of the content of each of the chapters. In the next chapter, I present a detailed critical literature review of the study, which includes perception and stereotypes and how they may influence people's choice to study Mathematics.

CHAPTER TWO: Literature Review

Planning and writing a literature review involves systematically identifying, locating and critically analysing documents that are relevant to the research study (Robson, 2011). The purpose of this literature review was fourfold: first, to review critically existing research that helped in designing this study; second, to influence the construction of the research questions; third, to identify any gap in the existing literature and finally, to serve as a guide in interpreting the findings of the research study (Robson, 2011). The literature review has thus been divided into six sections.

In the first section I critically review the literature, focusing on the concept of gender in relation to the social construction of gender; the social reproduction of gender; the concept of gender in relation to education and gender and equity in education. The second section consists of critical reviews of literature about gender and educational research, while the third section relates to gender and performativity across different subjects in the UK. This is followed by the critical review of literature on factors influencing the choice of academic subjects in general and on Mathematics in particular, inclusive of the theoretical framework for the study (based on the General Model of Academic Choice (Eccles, 2011)) and then the conclusion.

The main purpose of this study is to investigate the factors influencing the choice of Mathematics at A-level from a gender perspective. The following research questions are serving as guides to this research:

1) Are there any differences in examination performance in Mathematics between boys and girls at GCSE?

2) Are there differences in the number of boys and girls pursuing A-level Mathematics?

3) What factors influence the choice of Mathematics at A-level?

4) What are Mathematics teachers' perspectives on gender and the choice of Mathematics at A-level?

5) What are students' perspectives on gender and the choice of Mathematics at A-level?

The structure of this chapter is based directly on the main purpose of the study and the research questions which have influenced the choice of the themes (sections) and sub-themes (sub-sections) in this chapter.

2.1 Concept of gender

The concept of gender is one of the driving forces of this study and therefore understanding this concept is an important aspect of it. "Gender" refers to roles, responsibilities and behaviours created by society that are believed to be associated with either males or females (Giddens et al., 2013). Physically or biologically, there are differences between males and females. These are easily identified by the body shape, the voice and other aspects of physical appearance (Kisseadoo, 2009). In the view of Nobelius and Wainer (2004), any differences between males and females which are not absolute, such as physical or biological differences, can be considered as issues of gender. According to Nobelius and Wainer (2004), "sex" is an acknowledged biological fact about a person based on chromosomes and sex organs. Such differences are the same irrespective of culture, whereas "gender" describes characteristics which society ascribes as either masculine or feminine. These characteristics may differ across cultures (Nobelius and Wainer, 2004). This is why the concept of gender extends beyond biological differences between males and females. According to Butler (2007), gender relates to how society perceives or expects males and females to act or think. Gender identity is therefore ones' sense of identifying as either a male or a female (Giddens et al., 2013). In the next sections, I discuss how these perceptions and roles are created and perpetuated. In the next sub-sections, I discuss the concept of gender in relation to concepts of the social construction of gender and social reproduction of gender, as well as gender as a concept in education and equity in education.

2.1.1 Social construction of gender

In the view of the social constructivist, there is no natural truth in gender; it is constructed by society's expectations and gender-defined roles (Butler, 2007).

Stuber et al., (2011) hold the view that the process of socially constructing gender happens through the teaching of perceived gender differences via social interactions and within social institutions such as families, workplaces, schools and religious environments. Socially constructed relationships include roles such as personality, behaviour, attitudes, values and relative power. When these relationships are attributed either to males or females, they become one of the means by which gender is socially constructed (Berkowitz et al., 2010). In some societies for example, the man is seen as the ultimate provider for the home, whereas the woman is seen as the carer for the house and children (Stuber et al., 2011). According to Giddens et al. (2013), gender is both socially constructed and pertains to one's sense of self.

The social construction of gender is apparent at different stages of life. According to Paul (2014), formal education is expected to play an important role in the process of liberating people from any nuance associated with gender. This is however not the case at all times, schooling has been found to play a major role in the construction of gender. Gunderson et al. (2012) found that female teachers were more interested in teaching in primary schools, but male teachers preferred secondary schools. The study further found that both male and female teachers, as well as students, perceive some subjects to be either associated with males or females. These kind of perceived differences between genders are all forms of gender construction in schools. There are many more research studies which have identified differences in gender in many school settings (Sakiza et al., 2012; Lerner, 2013). The relevance of the social construction of gender to this study has been discussed in Section 2.4, under "Factors influencing students' choice of academic subjects".

2.1.2 Social reproduction of gender

According to Doob (2012), social reproduction refers to any social structures or activities that transmit social inequalities from one generation to the other. Stuber et al. (2011) also explain that social reproduction involves activities, attitudes, behaviours, emotions, responsibilities and relationships that propagate social systems such as gender, class and religious systems. Gender-role theory, which is based on how societies have defined certain roles as male or female, is a form of social construction of gender. The continuous propagation of such theory leads to the social reproduction of gender. These roles are learnt through different means, including culture, upbringing and through the process of socialisation (Chang et al., 2011).

Educational institutions are often one of the first points of call when addressing the issue of social reproduction of gender (Haywood and Mac an Ghaill, 2013). Researchers such as Haywood and Mac an Ghaill (2013) and Paul (2014), have focused on the curriculum, approach to teaching, thinking about gender constructions among teachers and students to see if they have either become more "boy or girl-friendly" at the expense of the other. This study is no exception, since one of the aims of the study is to find out about teachers' and students' perceptions of gender and how these might be related to the choice of Mathematics at A-level. This therefore leads me to the concept of gender in education.

2.1.3 Gender as a concept in education

The educational system is part of the social system and therefore all educational institutions are rich sources of knowledge about gender construction and reproduction. The concept of gender in education has over the years, influenced the decision of policy makers in dealing with education. For example, the Equality Act 2010 seeks to establish equity among males and females in education in England, Scotland and Wales (CSIE, 2013). The formulation and introduction of the 2010 Act in itself is an acknowledgment that there are perceptions of differences between males and females in schools that need to be addressed. Wilson (2010), Gunderson et al. (2012) and Paul (2014) have attributed the causes of gender differences to factors such as stereotyping, teachers' influence and parental influence. Based on some of these perceived differences, the concept of gender in education can be linked with the concepts of gender identity, gender role theory, and equity in education. Gender identity is the way in which the individual sees himself/herself within defined gender roles (Francis and Skelton, 2014). Gender role theory is based on the assumption that socially, individuals are identified as either male or female based on a recognised role ascribed to a particular gender (Lerner, 2013). In this situation, a female can be identified with the defined roles of the male and vice versa. These defined roles can affect the choices students make. Sanders et al. (2010) believes that gender role theory does not work in favour of gender equity. This is because a defined role for any gender has the potential to narrow children's understanding and would not encourage any change to their prior knowledge of gender differences. In some societies, parents have had to make decisions about their male and female children not based on their perceived abilities or rights to education, but based on sex and gender roles (UNESCO, 2011).

2.1.4 Gender and equity in education

Before the 1980s, Sutherland (1981) found that the concept of gender has not only identified that there was bias in the educational system towards males, but also that certain school subjects were dominated by males. Even though Sutherland's assertion was in the '80s, the 2009/2010 GCSE results in the UK show that, for non-compulsory subjects, more girls chose languages (e.g. Spanish, French, German) than boys and more boys chose Physics and Chemistry than girls (JCQ, 2010). The concept of gender has thus been an influential part of education where certain subjects have been associated with either males or females.

The concept of gender equity in education seeks to tackle the social reproduction of gender inequalities in education. Equity in education aims to ensure that both males and females are given equal access to education (Equality Act 2006). The Equality Act 2006 also implies that both boys and girls should have equal opportunity to choose any school subject in the UK, but to be equipped equally for that subject is another matter. One of the enemies of equity in education is the social construction of gender. Haywood and Mac an Ghaill (2011) argues that before the child is born and reaches school age, certain gender norms have already been established in them. Changing this process is very slow, as it has been set in motion very early in a child's life (Haywood and Mac an Ghaill, 2011). This means that achieving gender equity in education is a Herculean task, which goes beyond just giving equal access to education.

The position on equity in Mathematics education held by the National Council of Teachers of Mathematics (NCTM) is that equitable practice should encourage both teachers and students to value, respect and believe in the work of the classroom community. The main aim is for each individual to build a positive image about Mathematics based on their own roots and cultural background (NCTM, 2008). The NCTM makes the assumption that irrespective of one's roots or cultural background, Mathematics has always been in existence and has always been used by both males and females. The NCTM identified different factors contributing to achieving gender equity in Mathematics education. These include incorporating individuals' roots and cultural backgrounds in the learning process. The NCTM's position does not however explain situations where a person's roots and cultural background do not encourage them to study Mathematics. In this situation, the cultural background of a person could therefore be a disincentive to achieving gender equity in Mathematics.

There are different aspects to the achievement of equity in Mathematics education. Fennema (1990) argues that equity does not mean using the same teaching method for everyone in the class, but varying the approach to suit individual students in order to achieve the goals set for the class. These include equity through separation and differentiation as a teaching style. Fennema's views are still relevant today, because the uniqueness of a person cannot be ignored and this can be the basis for forging equity in education. Equity in this situation is ensuring that learning opportunities and educational treatment are applied equally. More importantly, there should be no significant differences in what students of either sex have learned by the end of the specified period of schooling, (Fennema, 1990).

In some situations, achieving equivalent outcomes in Mathematics education may mean that teachers actually need to treat male and female students differently (Fennema, 1990). This could even lead to separating the female students from the males. Raynor (2008), on the other hand, suggests that rather than establishing equity by separation, effort must be made to establish equity in co-educational schools without separation. In her view, even though individuals may have their preferred style of learning, they can still learn other styles from mixed-gender classes. Having a supportive educational environment tailored towards the need of both sexes at all levels irrespective of institution can bring about equity in learning Mathematics. There are instances of single-sex schools having been found to perform better in Mathematics than co-educational schools (Rex, 2009; Aldridge, 2011). There are also studies that have found that women from single-sex schools are more likely to pursue further education in Mathematics-related subjects than women from co-educational schools (Phillipps, 2008; Picho and Stephens, 2012). According to Drury et al. (2013), single-sex schools are more important in the countries of the global South (e.g. Nigeria, Columbia, Mexico) for bridging the gender gap in education enrolment and Mathematics in particular. This view seems to suggest that introducing more single-sex schools in developing countries could address the problem of gender gaps in education. However, it would not be wise to increase the number of single-sex schools with the sole purpose of ensuring gender equity. Besides being an expensive venture, other subject areas may not need such intervention as a way of ensuring gender equity. For instance, Aldridge (2011) found that in the US, the performance in reading attainment lessons of female students taught in co-educational classes was higher than those in single-sex schools. The males in single-sex classes, on the other hand, performed better in both Mathematics and reading than those who were taught in co-educational classes. This shows that instead of single-gender institutions, single-gender classes could be another option for achieving equity in Mathematics education.

In conclusion, the concept of gender consists of socially constructed roles attributed to males or females, socially reproduced through different means including culture, identity and class. These roles take into consideration personality, behaviour, attitudes, values, career and relative power. Gender construction starts from birth and schooling should be a place to halt gender reproduction, but this is not the case (Paul, 2014).

2.2 Gender and educational research

The focus of educational research on gender in Mathematics education changes over time. In the 1970s and ‘80s in the UK, gender and Mathematics studies had focused on the underachievement and marginalisation of girls in comparison to boys. In the 1990s however, the trend shifted to concerns about the underperformance of boys (Francis and Skelton, 2014). Lubienski and Bowen (2000), studied 3,011 research works on Mathematics education between 1982 and 1998 from the Educational Research Information Centre (ERIC) database and found that 623 of the articles focused on four categories of equity in Mathematics achievement; gender, disability, ethnicity and class. Out of the 623 published articles, 323 of them focused on gender. This shows that issues of gender in educational research continue to be very important.

The Educational Reform Act of 1988 introduced core compulsory subjects at GCSE into the National Curriculum of England and Wales. These included Mathematics, English and Science. Francis and Skelton (2014) argue that this introduction brought with it improvements in performance in both genders, but more rapid improvements among girls. Not only did girls outperform boys in the language subjects, but also caught up with them in Mathematics and Science (JCQ, 2010). Despite these improvements, Francis and Skelton (2014) hold the view that many features of girls' educational knowledge and experiences continue to be affected negatively by masculine values and expectations reflected in educational institutions. For instance, boys continue to dominate the classroom space and tend to attract the teachers' attention in classrooms more than the girls (Francis and Skelton, 2014). Sakiza et al. (2012) also found that the encouragement that male students receive from their Mathematics teachers at high school helps in deciding to continue further in Mathematics or Mathematics-related careers. The surprising aspect of Sakiza et al.'s (2012) study is that encouragement helps females to perform better in Mathematics, but does not affect their interest in Mathematics. These kinds of perceived gender differences have shifted the emphasis of research towards focusing on finding out why boys are underperforming and why girls are not interested in further study in Mathematics (Shapiro and Williams, 2012; Watson et al., 2010). The current trends in educational research on gender suggest that feminist educational researchers are more concerned with women's education and the gender equity in schools, whereas masculinist researchers are concerned with the underachievement of boys (Shapiro and Williams, 2012; Watson et al., 2010). In Canada, the focus of the research on gender and Mathematics (and science-related subjects) since the 1990s has shifted from underperformance to underrepresentation of girls and women (Sterenberg and Hogue 2011).

Responses to the issue of underperformance of boys in education and underrepresentation of girls in Mathematics (and Mathematics-related subjects), have led contemporary research on gender in Mathematics education to focus on Mathematics identity, classroom climate, classroom behaviour, differences in learning style and other perceived factors attributed to differences in gender (Roberts, 2012; Sterenberg and Hogue 2011). The classroom climate may involve the kind of posters displayed in the class, or teachers' language and examples used in class. In a class, some may be comfortable with activities involving memorising and others will prefer engaging with an activity (Geist and King, 2008). There are others who prefer visual, reading and writing, auditory or kinaesthetic forms of learning. Wehrwein et al., (2007) argue that men and women do not learn differently, but each may have a preferred way of learning. However, in a study on gender differences and learning style, Wehrwein et al., (2007) found significant differences between the learning styles of males and females. In a study comparing single and multiple modes of information presentations among undergraduate students, Wehrwein et al., (2007) found that more males preferred multiple modes of information presentation. The female students, on the other hand, preferred single modes of information presentation. "Single mode of presentation" refers to the use of one of the four learning styles (visual, reading and writing, auditory or kinaesthetic) in a lesson, whereas "multiple mode of presentation" refers to the use of two or more learning styles in a lesson. Despite these findings, Wehrwein et al., (2007) recommend mixed-gender classrooms and study groups as ways of helping students adopt different styles of learning. These are but a few examples of contemporary research seeking answers to issues of underrepresentation or underperformance by gender in education.

In conclusion, the choice of this research topic is in response to the current problem identified in the UK. In the 1980s, the underrepresentation of girls in higher level Mathematics could have been attributed to underperformance, but the current trend of underrepresentation of girls cannot be attributed to underperformance in Mathematics (Arnot and Mac an Ghaill, 2006). In recent years, girls have been performing very well in Mathematics in GCSE but are underrepresented in Mathematics at A-level and beyond. During those periods when girls were underperforming, researchers attributed this to the curriculum and mode of teaching Mathematics being biased in favour of boys (Sutherland, 1981; Fennema, 1990). Whatever interventions that were introduced led to improvement in performance of girls but fell short of increasing their interest in pursuing education in Mathematics (or Mathematics-related subjects) further. This is why this study shifts the focus from why girls are underperforming to why girls are underrepresented in A-level Mathematics. It is based on this that one of the aims of the study is to understand the factors influencing students' choice of subject at A-level. The next section therefore reviews literature on gender and performativity across different school subjects. This is done in comparison with Mathematics at GCSE and A-level in UK.

2.3 Gender and performativity across different school subjects

According to Martensa et al. (2011), gender-based differences in performance are not restricted to any particular age group, but occur from nursery through to university. For example, in a medical school in the US, White and Welch (2012) found that, during the first year of an undergraduate course, male students were found to be better at performing laparoscopic surgery than female students. However, by the end of the fourth year, there were no such differences in performance. In England at the end of 2013 in Key Stage 2, 86% of girls and 86% of boys attained level 4 and above in Mathematics (DfE, 2014). Earlier in 2007, 76% of the girls achieved level 4 and above compared with 78% of the boys. Similar trends were observed in 2008 and 2009. This implies that the trend in performance at Key Stages 1 and 2, can differ from GCSE level and this can subsequently differ from that at A-level. The first research question of this study seeks to establish whether any gender-based differences in examination performance exist in Mathematics at GCSE level and the second research question focuses on differences in gender representation in Mathematics at A-level.

Noyes and Sealey (2012) in a case study of a school in the UK on the drop-out rate for A-level subjects at year 12 (i.e. at the beginning of A-level courses), found that Mathematics has a high drop-out rate compared to other subjects. Noyes and Sealey's (2012) study did not focus on gender and therefore there was no mention of which gender had the highest rate of drop-out. According to Mendick (2005), rather than seeing Mathematics as absolute knowledge, Mathematics should be seen as many things to many people. Mendick emphasises the importance of Mathematics not only as a school subject, but the links between Mathematics and the curriculum of other school subjects. Mendick (2005) therefore argues that the high drop-out rate in A-level Mathematics in Year 12 in the UK is a result of students not being given the chance to explore what Mathematics means to them and what they can do with A-level Mathematics. Mendick's view is however oversimplified, when you consider that Brown et al (2008) identified perceived difficulty and lack of confidence in both male and female students as some of the factors leading to the high drop-out rate in A-level Mathematics. Noyes and Sealey (2012) stress that there is a great departure from the teacher-led approach to teaching at GCSE level to more emphasis on independent student learning at A-level, with the teacher as facilitator.

Korpershoek et al. (2013) found that in the Netherlands, despite girls performing better than boys in secondary school (pre-advanced) Mathematics, fewer girls than boys go on to study advanced Mathematics. In a similar study in the UK on women in Science, Technology, Engineering and Mathematics (STEM) careers, Kirkup et al. (2010) found that between 2006 and 2009, girls have performed better than boys in GCSE Mathematics. All these findings suggest that there has been an improvement in girls' performance in male-dominated subjects but there is no corresponding increase in girls' participation.

A study of colleges in the Philippines found that male students perform better than female students in college algebra (Garcia, 2012). In a similar study in the US, Hauk et al. (2015) did not find any gender differences in performance in algebra, in contrast with Garcia's findings. Carraher et al. (2006) take the view that irrespective of gender, early introduction of algebra during the early stages of education promotes pupils' confidence, interest and builds a strong foundation in Mathematics. It is therefore evident that the issue of performativity varies in different places. On attitude to learning, Arroyo et al. (2013) found that female students were more open than males to seeking and accepting support. De Lourdes Mata et al. (2012) on the other hand, found a continuous decline in the attitude of girls towards learning Mathematics as they progressed in schools.

2.4 Gender and Government policy

The Equality Act 2006, which came into force in England in 2006, sought among other things, to promote equal opportunities between male and female (CSIE,2013). Steinberg (2007) argues that policy change on gender is easily embraced by governments if such changes focus more on economic factors than just advocating for gender equality. Annesley and Gains (2013), in a similar view, argue that advocates for policies on gender equality have focused their argument for equity based on equal representation and gender population of a state. Emphasis should shift from just the need for equal representation to the economic importance of gender equality.

Beede et al. (2011) for example sees female involvement in Mathematics as a means of bridging the gender wage gap. The UK Government sees the manpower development in Mathematics as a key factor in economic growth (DfES, 2004). This cannot materialise if policies are not put in place to ensure that both males and females are encouraged to study Mathematics. In this situation, the government working towards equity in Mathematics representation could lead to economic benefits.

2.5 Factors influencing students' choices of subjects

The main aim of this study is to investigate, from the gender perspective, the factors influencing the choice of Mathematics at A-level. Different factors have been identified as influences on students' choices of academic subjects. Eccles (2011a) identified that from a gender perspective, the influences of peer groups, teachers and parents were some of the factors affecting students' choices of academic courses and careers. In the latter case of students' perception of gender, this includes stereotypes and students' perceptions and attitudes towards subjects (Stoet and Geary, 2012). This section therefore examines the extent to which the aforementioned factors influence the students' choices of academic subjects in general.

2.5.1 Peer group influence on academic choices and performance

According to Bensona et al. (2012), the increasing influence of the peer group is one of the important stages of transition from childhood to adolescence. At this age, adolescents spend more time in school than any other place. Schools are therefore places for further dissemination of perception of gender-role differences (Eccles and Roeser, 2011). This may come through gender-type leisure activities and the way in which peers express their career intentions. Consequently, the students' experiences in school influence their development during adolescence. These include the choices they make and their intellectual development (Eccles and Roeser, 2011). Communication between peers in the classroom and outside of school is a means through which gender is constructed. Steffens and Jelenec (2011) on the other hand, see the peer group as good grounds for motivation and encouragement.

As adolescents go through puberty, their peer groups play an important role in these changes. The areas the peer group affect most include their achievements (e.g. academic, sports etc.), motivation, decisions, behaviour and beliefs (Steffens and Jelenec, 2011). With regards to achievement, motivation and decisions Steffens and Jelenec (2011) found that in the US, students are more like to associate with colleagues who have similar academic interests and characteristics. For example, high academic achievers tend to relate to other high achievers and low achievers likewise associate with low achievers. Steffens and Jelenec (2011) however, found that this kind of association has little effect on students' beliefs about their success. In another study, Robertson and Symons (2003) found that peer group does influence academic attainment but the study could not identify how it does. Summers' (2003) study found that the quality of peer friendship can significantly predict academic and social goals of those in that peer group. The findings of Summers (2003), suggest that where the majority of members of the peer group have high aspirations, it does affect others positively and vice versa. Students who belong to a class with shared goals and valuing academic goals of peer learning are likely to be influenced by the group in the choice of academic subjects as they move through different stages of their academic career. So if the group does not value academic goals or if it has low aspirations, then motivation could be hampered. Peer groups can thus have either negative or positive effects on achievement and motivation. Wang et al. (2013) take the view however that at the advanced stages, peer groups' influences on the choice of subjects and careers are very minimal. Peer influence on gender and the choice of school subjects also depends on the proportional representation of genders in a classroom. For example, a study of students in elementary, middle, and high schools in the US, Lavy and Schlosser (2011), found that the performance of both boys and girls are enhanced where the population of girls in the class is greater than boys. In their view, the lower levels of classroom disruption and violence they identified in such classrooms could be attributed to this.

Schneeweis and Zweimüller (2012), in their study in Austria, found that girls do better in Mathematics than boys in secondary schools. They also found that girls are more likely to further study Mathematics if they are educated in single-sex classes or schools. They argued that co-educational settings appear to strengthen gender stereotypes; single-sex education on the other hand gives girls more freedom to explore their interests and abilities in Mathematics and Mathematics-related subjects. Peer group influence is therefore an important factor in this study because it has a direct link with academic performance, motivation and decision-making in the choice of career and academic subjects.

2.5.2 Teachers' influence on academic choices and performance

Fennema (1990), who adopted the model *"The influence of teachers' knowledge and belief on students' learning"* in her study on gender, suggested that teachers' knowledge affects the decisions they make. The teachers' theories and belief systems affect the students' knowledge, perceptions, actions and plans in the classroom as well. The students' cognition is therefore affected by the classroom instructors. Therefore, what teachers know and believe about gender is passed on to students and could become some of the knowledge and understanding of the gender differences in Mathematics that students may hold.

Not only does students' cognition affect their perception of gender, it also affects their behaviour and vice versa. Teachers, on the other hand, are influenced by students' behaviours, which subsequently affect the teachers' decisions and perceptions.

The beliefs of the teacher could either be beliefs about themselves or what the teacher holds about others. In this study, it is necessary to know whether teachers have equal expectations of both genders in learning Mathematics. This is because teachers' expectations about a student could either encourage or dissuade them from Mathematics (Gunderson et al., 2012). Gunderson et al. (2012) argue that for gender and Mathematics, the students' beliefs about themselves and the teachers' beliefs about others play an important role in the choices students make. In a study in Turkey, Uysal (2009) found that contrary to what existed previously, the modern teacher in Turkey has equal expectations of both male and female students in learning Mathematics and pays equal attention to both genders. In another study in the US, which sought to find out the relationship between the perceptions of special education teachers and beliefs of the student, the more favourable teachers' perceptions are towards the students, the better they perform (Jackson, 2011). This implies that if teachers believe that both males and females can perform equally in Mathematics, they are likely to give them equal attention. The teachers' past experiences or perceptions, if not challenged, can also become the basis for their current beliefs. For instance, in a study in Australia, despite observing no significant differences in the general performances of single-sex girls-only schools and girls in co-educational schools, teachers were found to hold the belief that girls' achievements in single-sex schools are better than co-educational schools (Jackson and Smith, 2000). Identifying these beliefs and perceptions of teachers and how they influence teachers' support is an aim of this study.

Teachers play an important role in the decisions students make about their academic choices. Noyes and Sealey (2012) argue that prior to A-level, teachers could influence the choices of students, whilst at A-level there is little the teacher can do to influence the choices the students have already made. At the colleges in the UK however, academic tutors or counsellors have input when the students do not meet the entry requirements of the subjects they chose initially (Ofsted, 2013). Transition from GCSE to A-level is therefore an important stage during which teachers' contributions can affect the choice students make. In a study on the support and encouragement students received from their teachers, Watson et al. (2010) found that Mathematics teachers' encouragement of students in high school impacts on performance, but has less impact on Mathematics-related career aspirations. According to Watson et al. (2010), the encouragement that male students receive from their Mathematics teachers in high school helps in deciding to continue further in Mathematics education but not necessarily in a Mathematics-related career. For female students, the encouragement helps them to perform better, but not necessarily to go beyond their current education in Mathematics-related subjects.

Teachers are judged by the value they add to their students (Darling-Hammond et al., 2012). The value-added model uses statistical evidence to measure changes in students' performance over a specified period. According to Darling-Hammond et al. (2012), these values do not take into consideration a lot of important factors such as class size, prior schooling and challenges students may face outside the school environment. Performance is the main factor in this respect and the longer the period of evaluation; the better and easier it is for teachers to add value to their students' performance (Goldhaber and Hansen, 2013). Unfortunately, GCE A-Level covers a two-year period, which makes it difficult to assess effectively the value added within this period. Schools are therefore likely to make it easier to attract students with short term abilities rather than long term abilities at A-level.

In conclusion, the influence of the teacher on the students' decision making process about their Mathematics studies is very important to the aim of the study. In my view, this influence takes its root from the teachers' past and present interactions and perceptions about gender. This section is relevant to the study because my fourth research question focuses on the Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level.

2.5.3 Parental influence on the academic choices of their children

According to Hicks (2008), gender difference as a social-cultural issue can be a result of family transmission, arguing that in most cases, a child's interactions begin with the parents or close family members. In the early pre-school years, the conversations between children and parents are important tools for developing children's early concepts. The information that parents provide, either directly or indirectly, forms the basis for some of the children's concepts of gender in general and gender stereotypes in particular (Gelman, et al., 2004). These include offering gender-typed toys to children; encouraging or discouraging certain types of play on the grounds of suitability for the child's gender (for example rough play is traditionally associated with boys) (Maccoby, 2002). In a study conducted in the US to find out the impact of mothers on their three to six year-old children's sexuality, mothers were found to be more likely to talk to their daughters than their sons about reproductive bodies, romantic relationships and morality (Martin and Luke, 2010). McWhirter et al. (2013) suggest that a parent's expectations, support, gender-stereotyped aspirations, attitude towards Mathematics and sex-stereotyping of careers all impact on their child's career aspirations and ultimate choices.

According to Joe and Davis (2009), parents' expectations of their children depend on their cultural and ethnic backgrounds. For example, working and middle classes in the US have higher expectations of their children's achievements than their less affluent peers. Among African-Americans, parental beliefs and behaviours have a bearing on the child's cognitive performance in school (Joe and Davis, 2009). Asian-American parents and Chinese college parents were found to monitor and pressurise their children more, but offered very little assistance in their work.

Parents' occupations have been suggested to influence students' career choices. However, Fulcher (2011) takes the view that even though the student's perspective of their parents' occupations has the potential to positively influence the student's own career choice, it can also be a deterrent. Students who want to establish their own identity may not accept their parents' careers. Children who perceive that their parents are always frustrated with their present career may not be motivated to go for the same career. Ultimately this can shape students' career desires. Ojeda and Flores (2008), in a study in the US, found that both male and female students are more likely to choose a male-dominated career if their father is highly educated and in an executive occupation. On the contrary, female students with mothers in executive occupations are less likely to follow in their mother's footsteps, while the male students are more likely to do so. These findings suggest that, fathers have a major role to play in bridging any gender gap. Fathers have been found to have more sex stereotyped attitudes towards career and positive attitudes towards Mathematics. Stereotypes associated with Mathematics are learnt by children at an early age, which adversely affects their participation and performance in Mathematics (Muzzatti and Agnoli, 2007).

Chang et al. (2011) acknowledge that the gender gap has narrowed, but women are still underrepresented in Mathematics and Mathematics-related careers. In their view, parents hold the key to encouraging more females in these male-dominated careers. In analysing mother-child interactions from the Child Language Data Exchange System (CHIDES) among Korean-Americans, Chang et al. (2011) found that boys of the average age of 22 months are given more number-based activities than girls. Chang et al. found evidence to suggest the influence of cultural stereotypes attributing ability in Mathematics to the boy-child as the cause of this trend. In their view, this may not be intentional, but gender stereotypes of this sort are unconsciously reinforced by parents. They encourage parents to make use of numbers in their daily family conversations and engage with both genders. According to Fulcher (2011), as students advance, parents have little influence on their interests and choices and therefore if their interest has not been developed early, then it could be difficult.

2.5.4 Career choice

Different contributing factors to a person's career choice have been identified. Among them are: gender; personality; parental influence; academic subjects; hobbies; financial remuneration and challenges. For instance, Pociute and Isiunaite (2011) found that in making decisions about their careers, students who were undecided paid more attention to the financial benefits of a career, whereas those who had already decided were influenced more by their hobbies and interest in their current subjects. According to Pociute and Isiunaite (2011), lack of information about the self, occupations and about the way decisions are made are major difficulties in career decisions for students. What makes career choice an important aspect of this study is that at A-level, students are likely to be influenced by a career associated with their choice of subjects (Pociute and Isiunaite, 2011). What knowledge do students have about the benefits or importance of Mathematics in their future careers? In my view, their perception of the usefulness of Mathematics in future careers, confidence and encouragement can affect participation in Mathematics courses at A-level.

On the issue of gender, Tomasetto et al. (2011) argue that a student's beliefs about gender and Mathematics does impact on an individual's assessment of their own competence in Mathematics, which inevitably affects their choice in any Mathematics-related careers. In the UK, this argument becomes less relevant, especially when girls are now performing well in Mathematics. It is however relevant if, despite performing well, they are influenced to accept that certain careers are a male domain. Correll's (2001) study, found that in the late '90s, despite data in the US at that time showing that girls were doing better in Mathematics than boys, a lot of girls still believed that Mathematics and science were more relevant to boys than to girls. According to VanLeuvan (2004), a girl's confidence in any discipline and the attitude towards that discipline affects their educational and career goals in that field. VanLeuvan (2004) explains that girls' preferences for biological sciences or pursuing a career in health or medical science can be attributed to their higher levels of confidence and expectations at succeeding in these courses than they may have in Mathematics. Correll's (2001) study found that even with the same grades and test scores, male students perceived themselves to be more competent in Mathematics than female students did. VanLeuvan (2004) argues that role models can play an important role in the career choices of women, especially in careers in which women are underrepresented. In spite of their strength, girls who are not challenged to fight for change are more likely to avoid careers they perceive to be male-dominated. Girls and indeed any minority group who do not encounter positive role models during their schooldays may fall prey to stereotype in their choice of Mathematics-related careers (VanLeuvan, 2004).

Wang et al. (2013) on the other hand, hold the view that female students are not opting for science and Mathematics-related careers not because of performance, but because they have more choices than male students. They argue that in general, female students outperform males not only in Mathematics or Mathematics-related subjects, but in other school subjects as well. As a result of this, girls have greater flexibility than boys in their choice of careers. The extent to which gender beliefs affect students' choices of subjects and subsequent career choices leads me to the next sub-section on students' perceptions of gender and the choice of subjects.

2.5.5 Students' perceptions of gender and the choice of subjects

The notion of students in relation to gender and more importantly the impact of gender roles in the choice of subjects are very important to this study. The fifth research question seeks to understand students' perceptions about gender and their choice of Mathematics. Perception is the way in which an individual creates an impression or judges something, an individual or a group (VanRullen and Koch, 2003). This is formed through observation and interpretation of existing information about the subject matter (VanRullen and Koch, 2003). This means that the way in which a person gives meaning to what happens around him/her, affects that person's perception. In my view, perception therefore encompasses stereotypes and attitudes. This sub-section looks at stereotypes and students' perceptions and attitudes towards school subject selection.

2.5.5(i) Stereotypes

A stereotype is usually a publicly-held belief about particular groups or categories of people (Taylor and Walton, 2011). They can be classified as prior assumptions based on standardised and simplified ideas about groups or individuals, which may also be exaggerated (Taylor and Walton, 2011).

Stereotypes come in different forms; religious beliefs, cultural, social, racial, ethnic and many more. Khan et al. (2012) take the view that stereotypes can be viewed from two perspectives; the perceiver and the target. In their view, the perceiver has cognitive and incentive for depending on stereotypes to make decisions. From the cognitive viewpoint, a stereotype is a mental shortcut that a person relies on to acquire information easily and quickly (Khan et al., 2012). The motivations come from what the perceiver stands to gain from such publicly-held beliefs (or stereotypes). These decision processes, from the perceiver's point of view, can be conscious or unconscious. Stereotypes from the target perspective are about documentation of the effect of stereotypes on the target group (Khan et al., 2012). Shapiro and Williams (2012) find that targets are either more or less susceptible to fulfilling the stereotype. This implies that a student's choice of school subjects can be consciously or unconsciously influenced by the society's widely-held belief about that subject. In this situation, those who are propagating the stereotype become the perceivers and the students, whose choices have been influenced by this stereotype, become the targets.

This can lead individuals to perceive themselves as members of a group and to behave in accordance with the resulting social identity. The target may not accept the defined perceptions about the group, but may still be affected by the negative repercussions of the stereotype. Stereotypes can be used either positively or negatively to organise or group people (Steele, 2010). Such stereotypes can be a vehicle for a personally-held belief or can serve as a challenge or a motivation for someone to be different (Khan et al., 2012). Gender-stereotype approval from children comes out as early as two years of age and undergoes rapid increase and important developmental changes, most notably between two and four years of age. Despite the early formulation of gender-stereotype statements among children, parents seldom negate their children's statements (LoBue and DeLoache, 2011).

According to social identity theory, people identify themselves in two ways; as a unique individual and as a member of a group (Stets and Burke, 2000). The identity of a person is threatened when the individual is compared with another person (Stets and Burke, 2000). In much the same way, the identity of a group can also be threatened when the group is compared with another group (Schmader, 2002). The threat of stereotype can therefore be described as concern about being judged by a negative stereotype, such as a group of people or tribe being classified as more intelligent than another or superior to another group (Steele, 2010). An example of such a stereotype is when women are assumed to have weaker Mathematics abilities than men (Steele, 2010).

Stereotypes have been found to be a threat to learning Mathematics. Logel et al. (2012) for instance, found that stereotype-threat increases anxiety. When women face stereotype-threat in a Mathematics class, they are likely to avoid it by dropping Mathematics and picking up other subjects. Logel et al.'s (2012) finding holds true when students have the option of opting out, for example, the study of Additional Mathematics at GCSE or A-level Mathematics. At GCSE however, Mathematics is compulsory. Logel et al.'s (2012) assertions on how girls react to the threat of stereotype may be difficult to prove or may take a different form in this case. Mendick's (2005) study found that there are fewer female than male students studying Mathematics in England wherever Mathematics is not a compulsory subject.

In a study conducted in primary and middle schools in Italy, the threat of stereotype was found to contribute towards gender differences in performance in Mathematics (Muzzatti and Agnoli, 2007). According to the study, the less knowledge girls had about the negative stereotyping of Mathematics as a "male subject", the better they performed. In another study, McIntyre et al. (2003), found that stereotype-threat affects performance negatively, especially in circumstances where the stereotype identify one group as underperforming. This is more pronounced among stigmatised individuals (Beilocka et al., 2007). Schmader and Johns (2003) found that stereotype-threat has the ability to reduce the working memory capacity of some individuals in the group. O'Brien and Crandall (2003) found that the threat of confirming a negative stereotype could enhance performance on easier task but adversely affect the performance on difficult tasks.

In comparing a single-sex (all-girls) high school with co-educational high schools in the US, Cruz-Duran (2010) found that the girls in the single sex school had higher Mathematics grades, performed better on a given Mathematics task and endorsed fewer stereotypes in the questionnaires than girls in co-educational schools. In a similar study in Uganda, Picho and Stephens (2012) found that the threat of stereotype did not have any negative effect on the performance of girls in single-sex schools, but it did on girls in co-educational schools. In another study involving a single-gender (all-girls) Mathematics class and mixed class in a co-educational middle school in the US, Phillipps (2008) found that the single-gender Mathematics class performed better.

Halpern (2000) is also of the opinion that social stereotyping influences girls' self-concepts and expectations of success in Mathematics. This in turn influences girls' cognitive experiences. Jarvela (2001) is confident that cognitive as well as emotional and socio-cultural factors determine female students' responses to Mathematics. In the view of Hargreaves et al. (2008), the attitudes of teachers and parents are often reflective of cultural stereotypes regarding superiority of one gender over the other in Mathematics.

In addressing the threat of stereotype, a study in the US by Gresky et al. (2005) found that women's mathematical stereotypes are alleviated by continuous reminders of their strengths in multiple roles and identities. According to Gresky et al. (2005), some of these multiple roles and identities may not necessary be related to Mathematics but can impact positively on their performance in Mathematics. In situations where women were made aware or reminded of the achievements of other women, the women participants performed better irrespective of the threat of stereotype (McIntyre et al., 2003). However, the performance of women is not affected negatively under conditions of stereotype-threats if they do not acknowledge the importance of gender as a social identity. People from negatively-stereotyped groups who have a strong sense of identity from are usually not affected by the threat of stereotype (Schmader, 2002). Similarly, McIntyre (2005) found that greater alleviation from this stereotype threat is achieved when women read more about other women who have been described as successful because of internal stable causes such as their own abilities, rather than reading about other women who are seen as successful because of external unstable causes, such as their political affiliation or the person they are married to.

The reduction of this threat has the potential to cause a rise in the performance of females in Mathematics (Keller and Dauenheimer, 2003). In conclusion, even though threat of stereotype in gender and Mathematics education cannot be ignored, Stoet and Geary (2012) argue that there are other factors that could help close gaps in A-level Mathematics participation.

2.5.5(ii) Perception and Attitude

Perception is one of the processes by which we make decisions about our world (Lerner, 2013). Attitude, on the other hand, is a way one expresses his/her likes/dislikes of things (Lerner, 2013). Seeking answers to research questions 4 and 5 requires understanding of teachers' and students' perceptions about gender. Chatzistamatioua et al. (2013) state that, student's perceptions and interpretations of past experiences; play an important role in their contextual motivations and attitudes towards Mathematics. This suggests that a student's like or dislike for Mathematics could also be a result of past experiences or encounters with their teachers, parents or fellow colleagues. Teachers also have their past experiences and these can directly or indirectly affect their interactions with students, as well as their methods of teaching.

Social factors have had great effect on people's perceptions and these are expressed in the forms of emotions and interest (Sutherland, 1981). The students' perceptions are viewpoints, beliefs, opinions, and feelings about situations, people and events (Jarvela and Järvenoja 2011). A person's belief may have been influenced by past experience and may not take into consideration current changes. Lawrie and Brown (1992), who also studied students' perceptions at A-level in the late '80s in the UK, found that girls from co-educational schools see Mathematics as less enjoyable and more difficult than their colleagues from single-sex schools.

According to Chatzistamatioua et al. (2013) positive self-esteem and self-efficacy will result in positive self-concept. Self-concept is a cognitive assessment of what an individual makes of his/her expectations, beliefs, hypotheses and assumptions. Self-esteem as a concept in this study is about how a person evaluates herself/himself (Chatzistamatioua et al. (2013). Girls' confidence in Mathematics has a direct influence on their attitude. According to VanLeuvan (2004), a decline in girls' confidence in Mathematics affects their attitude towards the subject as well. Boys have a significantly more positive academic self-concept (i.e. self-esteem and self-efficacy) in Mathematics than girls (Chatzistamatioua et al., 2013). As girls grow up, Mathematics self-concept continues to be influenced by others' perceptions of them, whereas in boys, this effect is absent. This may not always be the case. In single-sex girls-only schools, female students can assess themselves better without being assessed by others. On the other hand, Chatzistamatioua et al. (2013) argue that the presence of boys may affect the self-concept of girls in Mathematics, or that the teaching methods in co-educational schools favour boys. Gelman et al. (2004) found that adolescents' self-perceptions play a large role in the choice or otherwise of Mathematics and career decisions as a whole.

Females' lower expectations of themselves may not always be based on anxiety, but on a realistic appraisal of social factors (Sutherland, 1981). Sutherland (1981) suggests that education does not only depend on the school system, but also on the home background and in some cases, the neighbourhood background. The choice or interest in a school subject can therefore be influenced by social factors. Reuben (2012), in explaining constructivism, explained that our construction and understanding of the world are shaped by our reflections on our own experiences. We consciously or unconsciously develop rules as a result of the contact we make with people. Some of these rules go a long way in influencing the students' later interests. Students' present perceptions and understanding of their past experiences inform their contextual drives (Chatzistamatioua et al., 2013). There is therefore a link between performance in Mathematics and confidence**.** Higher achievement in Mathematics is associated with higher levels of confidence in Mathematics (Barkatsas et al., 2009). More recently, higher confidence in using technology has been identified to improve achievement in Mathematics (Barkatsas et al., 2009). When gender differences in Mathematics achievement favour the male, Meyer and Koehler (1990) also found a corresponding gender difference in confidence. According to social cognitive theory, self-efficacy is enhanced through the individual's mastery experience, sensational experience, social persuasions, and physiological or emotional states (Bandura, 1997). This shows that confidence building, irrespective of sex, can be a great tool for teaching Mathematics and for bridging any gender gaps in Mathematics. In the US, Svartoien-Conway (2000) interviewed 20 female college students, each with different high school backgrounds (i.e. either single-sex or co-educational) and found that women from single-sex schools tended to have more self-confidence than their counterparts from co-educational schools. However, Brutsaert and Bracke (1994), in similar research in a different college in the US, did not identify any differences. These findings reinforce the point that the observed gender differences in Mathematics performance are not universal (Hedges and Nowell, 1995).

Svartoien-Conway (2000) and Brutsaert and Bracke (1994) suggest that girls' confidence in Mathematics can be enhanced through separation. Carraher et al (2006), in a study about the early introduction of algebra in the USA, found that irrespective of gender, pupils' confidence in Mathematics is boosted with early introduction to algebra. In their study, they found that pupils who were introduced to algebra before the age of eight were found to more confident later on in Mathematics than those who were introduced to algebra after 12 years.

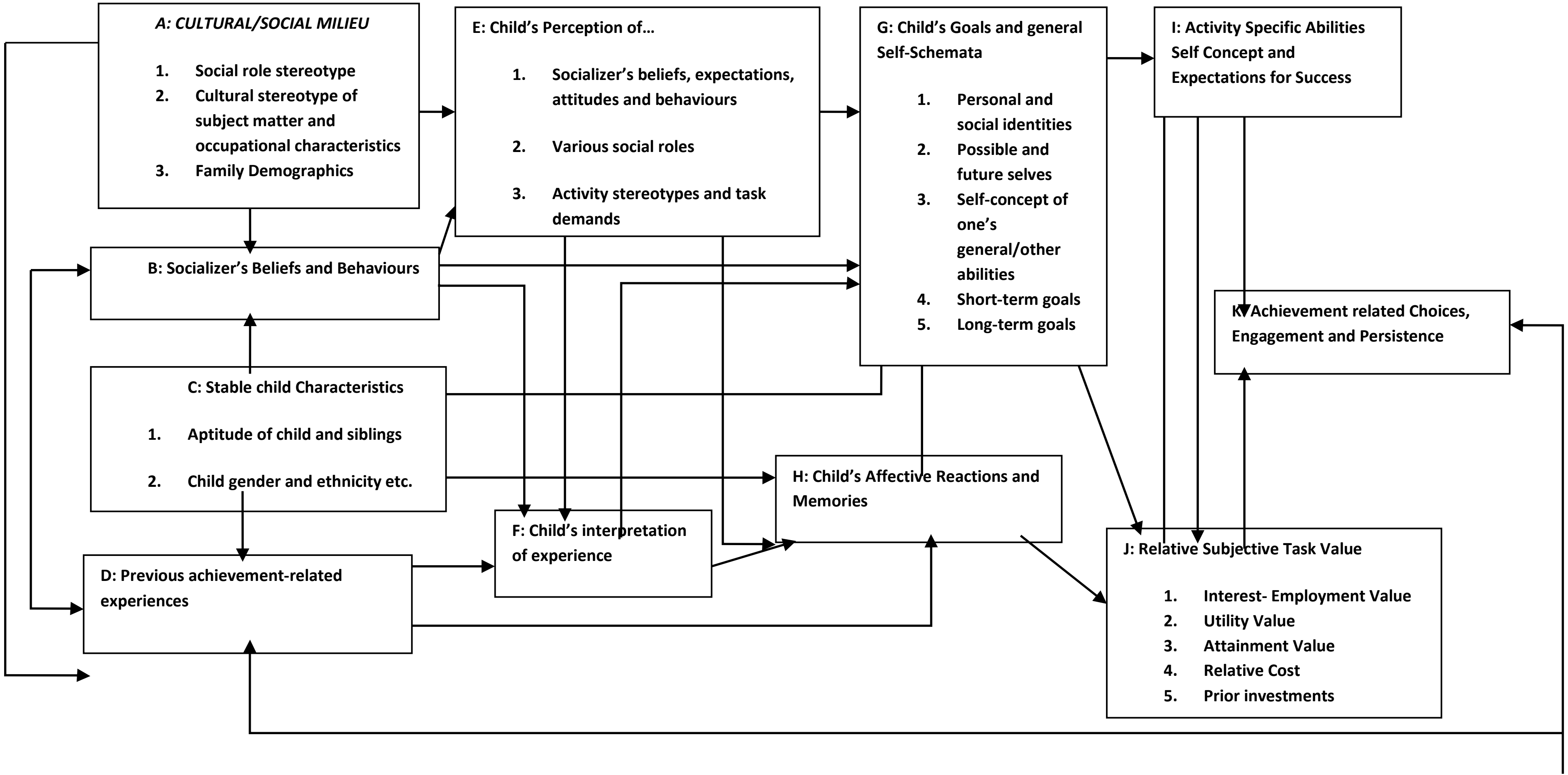
Improving girls' positive attitudes and perceptions towards Mathematics could be a key to encouraging higher participation in Mathematics. Developing a child's belief about his/her competence will impact positively on the child's motivations, achievement and self-esteem (Jacobs et al., 2002). Barkatsas et al (2009) argue that changing girls' attitudes towards technology, for example, could consequently change their attitudes towards Mathematics. In their study, they found that low levels of Mathematics achievement were also associated with low confidence in the use of technology and negative attitude towards Mathematics. The central factor to female students' participation in Mathematics at every stage of their career is confidence (Shapiro and Williams, 2012). In conclusion, since this study seeks to investigate the factors influencing the choice of Mathematics at A-level from a gender perspective, examining students' attitudes and perceptions towards Mathematics are essential. It is important to know the extent to which the choices students make are influenced by other people.

2.6 The Theoretical/Conceptual Framework

A theory in social science can be a model, a metaphor or a framework for understanding a social event (Wellington, 2000). According to Wellington (2000), a theory can either be predictive, explanatory or both. The main aim of predictive theory is to use current occurrences to predict the future, whereas explanatory theory seeks to explain or test hypotheses that specify why certain observed phenomenon occur (Flyvbjerg, 2001). This study is explanatory and the reasons for this classification are explained in Chapter 3 (Section 3.5). In my study, the theoretical framework I adopt takes the form of a model. The role of the model is to make it possible to compare this study with other similar studies and also to provide some of the basis for interpretation of data (Wellington et al, 2005). The theoretical framework for this study is based on the General Model of Academic Choice (Figure 1) derived from Eccles (2011b). This is a revised version of an earlier one by Eccles et al. (1985). The model will also help to provide the basis for explaining the occurrences of gender differences with the aim of understanding the issues of gender and the choice of Mathematics at A-level.

There are different models associated with gender; these include the Mathematics Attribution Scale (MAS), Autonomous Learning Behaviour (ALB) and the General Model of Academic Choice (Fennema, 1990). The MAS is a model designed to measure students' attributions of the causes of failures and success in Mathematics. Among the factors considered under this model are the environment for teaching and learning and students' attributions to capability, effort and task (Fennema, 1990). The ALB model works on the assumption that gender differences in Mathematics are more prominent in higher level Mathematics. The factors considered under the ALB model include confidence and perception and the usefulness of Mathematics to the students. The General Model of Academic Choice was adapted from Eccles (2011b). This model (Figure 1), chosen for my study, is an explanatory model which is used to test hypotheses on gender and the choice of academic courses (Fennema, 1990). It incorporates all the factors in both MAS and ALB and other factors which are relevant to this study. This model has been tested by Fennema (1990) on a study on gender and Mathematics and was found to be very important. The model was designed to explain the factors influencing students' choices of academic courses, but it can also be applied to gender differences in the selection of Mathematics (Fennema, 1990). The model has been adapted by many researchers with different interests. Su et al. (2009) adapted this model to study meta-analysis of sex differences in interests. Brown et al. (2011) adapted it to study social cognitive career theory. Barnes et al. (2005) also used this model to explore sex differences in science enrolment intentions in Australia. The diagram below (Figure 1) shows the General Model of Academic Choice as illustrated by Eccles (2011b).

Figure 1: General Model of Academic Choice



Source: Eccles (2011b) Journal *of Social Issues, Vol. 67, No. 3, 2011, pp. 644--648*

The development of this model was influenced by the decision, achievement and attribution theories of behaviour as applied to Mathematics (Eccles et al., 1985). Behaviour decision theory is concerned with describing the beliefs and the manner in which a person incorporates their beliefs and values into their decision making (Slavic et al., 1977). Achievement goal theory relates to individuals in a defined context striving to achieve a personal goal. This may lead the individual to either adopt a task or personality-oriented activity in order to improve their abilities and thereby achieve mastery of skills (Friedel, 2007). Attribution theory is concerned with how people give meaning to events and it always attributes cause to behaviour (Powers et al. 1984).

The model works on the assumption that the cultural setting of a person influences the person's perceptions of social attitudes and expectations. A person's goals and the general self-planning of her/his life take their roots from the person's perceptions of social attitudes and expectations. Among the factors that influence a person's cultural setting is the issue of stereotypes. Another assumption is that one's experiences, which include past grades in Mathematics, influence the individual's interpretation of a similar or other events rather than the new event being considered independently (Eccles et al., 1985). For example, a person's past performance in Mathematics determines their future expectations. The extent to which a person performs in the future is attributed to the person's ability. However, Eccles et al. (1985) contradict this assumption by explaining that, girls have been found to perform equally well in Mathematics as boys during their formative years, but have not been expected to do as well in the future or are not likely to continue with Mathematics. The model also assumes that the decision of a person to opt for Mathematics is influenced by a lot of choices and is directed by values such as achievement, competency, sex-role values and the importance of Mathematics in future careers (Eccles et al., 1985). Dick and Ralies (1991), who also adopted and tested this model, found that socialisers (including parents, groups, teachers) play a central role in the model, as well as the argument that the influence of socialisers on students comes from their attitudes and expectations. Attitudes and expectations can become their source of experience, which could ultimately influence their interpretation of their experiences. The model shows that these influences are not one-way, because the reverse also holds true, that the past experiences of the students can influence their attitudes and expectations. In another model used by Boswell (1995), the assumption was that students' attitudes towards Mathematics are influenced by their fathers, mothers, peer groups and educational settings. There are also factors such as a child's previous performance in Mathematics and stereotypes influencing the current choice, which were not accommodated in the model used by Boswell, but did form part of the Model of Academic Choice.

In the view of Dick and Ralies (1991), career choices are also influenced by intrinsic factors such as intelligence and extrinsic factors such as salary expectations, cost and length of the training. In the General Model of Academic Choice (GMAC), the "socialiser" refers to people such as parents and teachers and their attitudes, perceptions and expectations towards the students.

The drawbacks of this model are firstly, that it does not take into consideration a person's different phases of growth. The model can therefore be used for the transition of one stage of the academic ladder to another at a time. This includes studying the factors influencing the choice of subjects during the transition from GCSE to A-level and from A-level to university. Secondly, the GMAC focuses on behaviours that can be observed and therefore fails to relate the internal beliefs of a person to the outcomes (Meyer and Koehler, 1990). For example, a person who is not sure of himself/herself, could be seen by this model as lacking in self-concept, but the extent to which this affects their performance cannot be measured by this model. Meyer and Koehler (1990), therefore recommended the use of scales such as Mathematics Attribution and Fennema-Sherman scales to address this shortfall. Finally, the variables in GMAC are many and are interdependent, such that it is easy for the researcher to be saddled with a lot of data.

Boswell (1985), in studying this model, identified three main factors contributing to women being prohibited from choosing Mathematics-related fields: external structural barriers; social pressures and women's internal barriers. External structural barriers are associated with sex discrimination against females in educational, business and scientific institutions. Social pressures relate to pressures coming from parents and peer groups that deter women from opting for Mathematics and Mathematics-related subjects. According to Boswell (1985) these pressures are sometimes expressed either explicitly or subtly in the form of negative feelings or attitude.

In conclusion, the importance of this model to the study comes from the fact that the model identifies the interactions of variables relating to gender differences in Mathematics and more importantly relating to this study. For example, there is a link between culture, perception and attitude. The model also takes into consideration those observable behaviours that can result from beliefs. Thirdly, the model suggests specific testable hypotheses, which make it possible to refine and adapt the model to similar fields of study (Fennema, 1990). Finally, this study is explanatory and therefore adapting the framework of the General Model of Academic Choice (Figure 1), could help in the analysis and interpretation of data collected for this study. All the factors that have been discussed under Section 2.5 and found to be relevant to this study have all been incorporated into this model.

2.7 Conclusion

The literature review has identified that differences in examination performances and participation do exist in various subjects at different levels including in Mathematics. The causes of these differences vary in different studies. Some of these differences have been associated with gender. Some of these factors have been suggested to influence the choices students make in the selection of academic subjects at different stages in education, including A-level. According to the literature, the extent to which gender differences affect the choice of Mathematics at A-level is not very clear. There is also a shift in emphasis in research in the UK, from female students generally underperforming in Mathematics to being underrepresented in subjects seen as being male--dominated. In the UK, the problem is not underperformance of girls in GCSE Mathematics leading to underrepresentation in A-level Mathematics, but rather girls performing very well at GCSE but not being interested in continuing study of Mathematics at A-level. It could be suggested that girls are discouraged from continuing to study A-level Mathematics because girls who opted for A-level Mathematics at earlier dates performed badly. On the contrary, those girls who have in the past opted for A-level Mathematics performed well. It is therefore necessary to investigate the factors influencing the choice of Mathematics at A-level from the gender perspective.

Finally, the choice of the theoretical framework (the model) has been guided by the relevance of the model to the study. The conceptual framework gives the broad idea and the ideology from the field relevant to the study. Developing the conceptual framework can be based on assumptions, concepts, beliefs, expectations and theories that support and enlighten the research (Robson, 2011). According to Lincoln and Guba (1985), the conceptual framework is part of the agenda for making the link between the analysis and the existing concepts. The conceptual framework sets out to explain either graphically or in narrative form the main factors to be considered in the study. The conceptual framework for this study is in both graphical (the model) and narrative in form, drawing attention to what is happening and why it is happening in relation to gender and Mathematics education (Robson, 2011).

CHAPTER THREE: Methodology and Methods

The aim of this chapter is to introduce the methodology and method used in this research study and to explain the rationale for their usage. I begin by discussing the meaning of the terms “methodology” and “method”, explaining their differences and how they are related. In the second section, I introduce the concept of the researcher's positionality before highlighting its significance in the research study. This includes explaining how any potential researcher bias was minimised. The third section looks at the research questions and their justifications. This is followed by a section focusing on the concept of “case study” and how it applies to this study. In the fifth section I discuss the meaning of sampling and how the sample was selected for this study. In the sixth section I explore the process of data collection, including examining and justifying the use of mixed methods; audio recording, in-depth interviews and questionnaires, together with their advantages and limitations. In the next section I examine the meaning of the pilot study, showing how it was used in this study and the changes it led to. This is followed by sections on data analysis, ethical considerations, including trustworthiness and a discussion about the issues arising from data collection and analysis. The chapter ends with reflections on the methodology and methods, including their limitations.

3.2 Methodology and Methods

A research method is the technique and process of gathering data (Mertler and Charles, 2005). The technique and process may take the form of interviews, administering questionnaires, observation and retrieving information from archives (Robson, 2011). In contrast, the research methodology involves the description, justification and evaluation of the methods chosen for data collection. Whilst the method involves the steps needed to go through in order to accomplish the task, methodology involves the analysis of any methods, rules or steps that are used (Robson, 2011). Wellington (2000) refers to research methodology as the act of choosing, reflecting, evaluating and justifying the methods used for the research. For example, if the method involved questionnaires and interviews then the reflection, reasoning and the justification that led to the choice of the method is referred to as methodology.

Methodology therefore influences the choice of the method. The choice of the method, on the other hand, is influenced by several factors, including personal preference, interest and the researcher's background (Clough, 2002). The methodology and methods can also be influenced by time and resources available, research questions, ethical and moral issues, sample size and the reasons for the research being carried out (Wellington et. al., 2005). These factors are indications that selection of the methodology and method involves the processes of reflexivity and reflectivity (Wellington, 2010). The selection of the methodology and method therefore has a lot to do with the positionality of the researcher (Wellington, 2010). Positionality is associated with ontological assumptions, epistemological assumptions and assumptions concerning human nature and agency (Wellington et. al., 2005). Ontological assumptions take into consideration how a person sees him or herself within the social world, while epistemology is the nature of the knowledge one already has and how that knowledge was acquired. The assumptions concerning human nature, on the other hand, are concerned with the ways in which human beings are believed to be able to act within the world (Wellington et. al., 2005). The selection of the research methods can thus be influenced by the researcher's positionality in terms of ontological and epistemological assumptions (Wellington et. al., 2005). These assumptions are some of the issues that make it important to reflect on my position as a researcher.

This research study was designed to investigate the factors influencing the choice of Mathematics for A-level students from a gender perspective. This is a case study involving three schools and the method of the study was based on mixed methods. The selection of mixed methods was driven by the aim of the study, the research questions, the literature review and my positionality, ethical consideration and the resources at my disposal. In the following sections, the rationale for the choice of the methods is discussed.

3.3 Researcher's positionality

As a researcher, I am aware of the potential influence of my positionality and how it can affect the choices made in relation to the topic, method and methodology and the study as a whole. My positionality is based on deep reflections on my past and present, including my background, values, ideas, motivation, knowledge and prejudices (Wellington, 2010). This section therefore reflects on the influence of my position in terms of access to examination data on the achievements of boys and girls; my experiences of teaching in boys-only and co-educational schools; my childhood experiences; experiences as a parent and my science background.

As a past employee of an examining body, the West African Examinations Council (WAEC) based in Ghana, I had privileged access to information about the performance of male and female students in Mathematics at both the Basic Education and the Senior High School examinations level. I have been involved in the preparation of documents involving analysing statistical data to ascertain the performance of boys and girls in various subjects, including Mathematics, in Ghana. From some of these statistics, I had noticed the difference in performance in Mathematics in relation to gender. There were instances where the performances in Mathematics of girls in single-sex schools had been better than those of girls in co-educational schools. A lot of factors may have contributed to this, among which is the issue of equity in separation, as earlier discussed in the literature review (Chapter 2, Section 2.1.4); the academic abilities of pupils selected to the schools and the performance of teachers in the schools. I have, since that period, always been curious about how performance in Mathematics could be improved irrespective of school selection processes, the type of school attended (co-educational or single-sex) or gender. There is no doubt that the interest I developed while working with WAEC in the area of gender and Mathematics and in statistical analysis of examination results has influenced my choice of this topic. This has also influenced my choice of numerical data as one of my methods of data collection and analysis.

I have experience of teaching Mathematics in both co-educational secondary schools and single-sex boys' schools. While in Ghana, I taught in both co-educational and single sex secondary schools. My experience in England, however, has been as a teacher in co-educational secondary schools and Further Education (FE) colleges. My training as a teacher and my subsequent teaching experiences at these various schools have given me a deep awareness of the different learning styles associated with the teaching and learning of Mathematics. These include the choice of examples to be used in class and the nature of homework, whilst ensuring that they are not biased towards either sex and that both male and female students can identify with the subject (Dympna et al. 2013). As a teacher, I know and also understand the importance of reflecting on my previous lessons in other to improve on the next ones. These kinds of reflections may have impacted on my epistemological assumptions and consequently may have a link with the conceptual framework of the study, in which I seek to promote equity in the teaching and learning of Mathematics. For example, Wellington et al., (2005) explain that a researcher who believes that most people will react to an action is likely to choose observation and experiments as techniques, whilst the one who thinks that in a society people are expected to make decisions, may select methods that will seek explanations and understanding.

The greater part of my upbringing as a child in Ghana involved my father, mother and five brothers. My parents were both teachers. The traditional cultural upbringing in Ghanaian society clearly defines gender roles. Household chores such as washing, cooking and tidying up of the kitchen are seen as a girl's responsibilities. On the other hand, chores involving fixing machines, cutting wood and any other physically demanding chores are generally regarded as boys' responsibilities. However, in my family, this was not the case. We grew up learning to do the work traditionally associated with both males and females. My perception of "male and female" types of work may have been affected by my upbringing, since my mother would do any work she had purpose to do, while my father wouldn't allow anyone to classify any work as being specifically intended for males or females. One person was therefore not allowed to keep to a particular chore for a long time, as we kept rotating among ourselves. So in spite of being brought up in a traditional gender-differentiated wider society, I did not experience any gender inequality in my family.

I am a father of three children now; two daughters and a son. Seeing my children grow and making meaning of life through their surroundings has had a particular effect on me. I cannot overlook my influence on them in their learning process, especially in learning Mathematics. My two daughters are strong in Mathematics and spend quality time learning the subject; but my son, though not particularly weak in the subject, has not shown much interest. I am not too sure if my enthusiasm in ensuring that my daughters are not at a disadvantage in learning Mathematics may be having an adverse effect on my son. I should ensure that I get the balance right.

Furthermore, I have a strong science background. Before I made the change to Mathematics education, my Bachelor of Science degree was in Engineering. This notwithstanding, I do not see myself as totally positivist, but also inclined towards interpretive research approaches. Positivist knowledge is considered to be objective, replicable, value-free and can be generalised (Wellington, 2010). The interpretive approach to research, on the other hand, seeks to explore different perspectives and insights into a situation from the participants' subjective point of view (Wellington et al., 2005). The interpretive researcher acknowledges that he/she can make an impact on the outcome. I can therefore infer firstly that my choice of statistical data from the examinations results is influenced by my leaning towards positivism and secondly, that my choice of interviews and questionnaires to find out people's perceptions is rooted in my interest in the contribution that interpretivist thinking, makes to research. This explains my choice of a mixed method approach for this study, which is discussed in Section 3.7.1.

My choice of case study research with schools, teachers and students as participants was not made on the basis of my association with the schools or participants (as an outsider researcher), it was made purely on the schools' rankings by DfES and the willingness of the schools to be part of the study. I do see myself as an insider in relation to being a Mathematics teacher and teaching in the UK, but with regard to the case study schools, my position as an outsider made it easier to promote trust and assure participants of confidentiality. On the other hand, my position as an insider teacher of Mathematics has also been positive since it gave me an opportunity to examine, understand and question some of the language and concepts used in Mathematics education in my questionnaire and interviews. I was also conscious of Dwyer and Buckle's (2009) assertion that insiders have a tendency to influence the interviewees with their perceptions and as result, every effort was made to allow participants to express their views with minimal interruption and influence from me, the interviewer. I have to acknowledge that for one particular school, my position as a temporary Mathematics teacher helped in gaining access. The main issue here is not whether one is an insider or an outsider, but has to do with one's ability to aim to be authentic, open, honest and deeply interested in participants and finally, be accurate in the reporting of what transpired (Dwyer and Buckle, 2009).

According to Lucas (2014), ontological assumptions can lead to epistemological assumptions, which subsequently lead to methodological considerations. The selection of the method is also influenced by the researcher's positionality in terms of ontological and epistemological assumptions (Wellington et. al., 2005). In this study, I chose interviews and questionnaires as the main sources of data collection. It is possible that my ontological assumptions, epistemological assumptions and assumptions concerning human nature and agency may have influenced this choice. This is because I hold the view that a person's life is shaped by his/her thoughts. What a person becomes is the product of what is processed in the mind. One's ability to affect or help someone else depends on one's knowledge of what goes on in the mind, therefore to attempt to know what a person thinks or why a person behaves in a particular way would undoubtedly involve talking to the person. These ontological and epistemological assumptions are the rationale for the choice of interviews and questionnaires as the main sources of data collection. This view is also supported by Robson (2011), who explains that information about what people think, believe and how these things affect their decisions can best be obtained using interviews and/or questionnaires.

3.4 Research Questions

The research questions enable the researcher to break down the intended purpose of the study. According to Bassey (1999), research questions are the engine that drives the whole research and therefore should be formulated so that they set out the agenda for the study. The following research questions are the main drivers of this study:

1. Are there any differences in examination performance in Mathematics between boys and girls at GCSE?

2. Are there differences in the number of boys and girls pursuing A-level Mathematics?

3. What factors influence the choice of Mathematics at A-level?

4. What are Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level?

5. What are students' perspectives about gender and the choice of Mathematics at A-level?

In Bassey's (1999) view, good research questions should make it possible for data to be collected and analysed. My research questions were formulated based on the aims of the study and the existing literature in the field. The formulating of the research questions was based on Fraenkel & Wallen's (2008) proposals. They suggested that good research questions must have four essential characteristics; to be feasible, clear, significant and ethical. In ensuring feasibility, I took into consideration the availability of resources, which includes access to data on examination results and access to schools, teachers and pupils. To ensure clarity, every effort was made to eliminate any ambiguities in the questions. This was done by wording and re-wording, and seeking other people's opinions to ensure that the questions carry the intended meaning. In arriving at the research questions, I also questioned the significance of each question in addressing the main research topic and the kinds of method or data required to address the questions. The issue of ethical considerations is discussed under Section 3.10.

The topic for this study is "Investigating the factors influencing the choice of A-level Mathematics from a gender perspective". Through this topic, the following aims were identified:

To investigate:

1. Any gender differences in performances of students in GCSE Mathematics

2. Any gender differences in participation in A-level Mathematics

3. Factors influencing the choice of Mathematics at A-level
4. Teachers' and students' perceptions of gender and the choice of Mathematics at A-level.

The purpose of Research Question 1 is to serve as a guide in addressing Point 1 of the aims of the study, while the purpose of the second research question is to address the second aim of the study. Unlike Research Question 1 which focuses on students' performance at GCSE level, Research Question 2 focuses on gender participation in Mathematics at A-level, using secondary statistical data based on the general results in UK for all subjects at GCSE and A-level (JCQ, 2012). In order to investigate the factors influencing the choice of A-level Mathematics from a gender perspective, there is a need to know the trends in performance by gender of pupils at GCSE level. There is also a need to know the trends in participation in A-level Mathematics. It is on these basis that Research Questions 1 and 2 become very significant to this study.

My attempts to find out any trends in gender performance and participation at GCSE and A-level Mathematics respectively led me to investigate the reasons for such trends. This is what makes the third research question important to the study. The approach to gathering data to address this research question is based on interviews and self-completed questionnaires.

The importance of Research Questions 4 and 5 is to provide direction in addressing the other aims of the study (Points 3 and 4 of aims of study above). The motive behind these questions is to find how people's (especially teachers' and students') perceptions influence students' choice of A-level Mathematics. Based on Robson's (2011) suggestion, interviews and questionnaires are among the best ways of seeking information about people's perceptions. The justification for the choice of methods for gathering data necessary to address the research questions is explained under Section 3.7.

3.5 Case Study research

This section begins by looking at the meaning of “cases” under case study research and what constitutes the “case” in this study. This is followed by the justification for the choice of case study as a strategy for this study, the classification of the case study and the rationale for this classification.

In this research, I have selected case study as the strategy for the study. A case may comprise of an individual, classroom, organisation, school, programme, or an event (Robson, 2011). A case can also be an account or a situation that can easily be identified (Bassey, 1999; Stake, 1995). According to Robson (2011), a case study is a strategy for studying specific case(s) that are currently occurring. The case study strategy employed here involves an empirical investigation in the context of real life situations, of three secondary schools (Robson, 2011; Yin, 2003). This is an empirical investigation seeking to explore the factors influencing students' choice of Mathematics at A-level from the gender perspective.

In case study research, the emphasis is on detailed contextual analysis on a limited number of events and how they are related to either each other or to other real life situations (Yin, 2003). In my study, it is impossible to study all the schools in the UK and therefore there is a need to limit the number of schools involved. Secondly, in investigating the factors influencing the choice of Mathematics at A-level, I am trying to find answers to "why" and "how" students make their decisions. As the researcher, I have no control over the decisions the students make. According Yin (2003), case study is the appropriate strategy in this kind of situation. The third significance of this case study is in its ability to produce knowledge based on the context of this study that allows people to develop from rule-based to reasoning and interpretation of issues (Seale, 2004). For instance, through case studies, Vygotsky and Piaget were able to make great contributions to the understanding of the cognitive and moral development of a person (Fraenkel and Wallen, 2008).

I have classified this study as an instrumental case study for the purpose of providing insight into gender differences in performance and the choice of Mathematics at A-level. According to Wellington (2000), instrumental case studies provide insight into a particular issue or clarify hypotheses. The cases may not necessary have similar characteristics, but may be chosen either to generate or understand theories (Wellington, 2000). In my study, each school is therefore not treated as a separate case; rather all three schools together form the case study. However, in situations where views expressed are peculiar to the school but relevant to the study, reference is made to the school. My choice of three schools to form the case study was to enable me to strengthen my findings based on replications, deliberation and contrasting comparisons of the three schools (Yin, 2003). This study is an example of exploratory and explanatory research. Both the research topic and the nature of the research questions make the purpose of the study both exploratory and explanatory. The purpose of exploratory enquiry is to find out what is happening, seek new insights and to assess the phenomena in a new perspective. Explanatory enquiry, on the other hand, is to seek an explanation of a problem or a situation (Robson, 2011). This study is however not evaluative, because according to Stenhouse (1988), the main aim of evaluative case studies in educational research is to provide in-depth information that could help identify or judge the merits and demerits of policies, programmes or other forms of guiding principles or practices. The aim of this study is not to identify or judge the merits and demerits of any policies or programme.

Case study research became the appropriate strategy for this study because the study relies on the collection of evidence about a particular current situation. In this case, this involves gender and A-level Mathematics, with the view of finding the prospect of either generalising or seeking context-dependent knowledge. The idea of generalisation is based on Bassey’s (1999) view of "fuzzy" generalisation. Bassey (1999) argued that, case study in educational research should aim at "fuzzy" generalisation and prediction. “Fuzzy” generalisations work on the assumption that when a case study seems to produce evidence of a relationship between two or more variables, then it can be implied that this relationship may exist somewhere else (Bassey, 1999). The choice of multiple methods of data collection to address the same research questions is to help focus on context from different perspectives and also to enhance trustworthiness, which will be discussed in Section 3.11.

3.6 Sampling

Sampling is a selection from a defined population. Population refers to all cases that may include people, organisations, structures or events (Robson, 2011). Sampling plays a major role in every research strategy. The type of sampling, whether simple random, stratified, classified or systematic, depends on factors such as why, where and when the research is conducted (Robson, 2011). Sampling in a research study can be determined by taking into consideration the purpose of the research, number of issues the researcher wants to control in the analysis and in the case of quantitative analysis, the type of statistical tests (Fraenkel and Wallen, 2008). In surveys and experimental design for instance, the primary aim of sampling is for generalisation from a sample selected from a population (Robson, 2011). The situation is however different for case study research.

The main use of sampling in case study research is influenced by a lot of factors including the purpose of the study; whether it is single or multiple case study and whether it is theory seeking or exploratory (Bassey, 1999). In this study, the emphases are on in-depth exploration, explanation and analysis of information. Statistical generalisation is usually made by taking into consideration the size of the population, but in case study, generalisations are made based on more in-depth analysis and rely on trying to test existing theoretical prepositions, define and test rival explanations or hypotheses, and finally to develop a framework for describing the case study (Yin, 2003). As a result of the above suggestions, the rigid application of rules and logic about sampling was not applicable in this case study research (Robson, 2011).

Multi-stage sampling was employed in this study. Multi-stage sampling is the selection of samples at different stages of the research and involves different sampling strategies at each stage (Fraenkel and Wallen, 2008). The first stage was the selection of the schools in which stratified sampling was used. Stratified sampling involves dividing the population into a number of groups with each group having particular characteristics (Robson, 2011). The conceptual framework and the research questions formed the basis of the characteristics of each stage and group. Since the study focuses on the factors influencing the choice of Mathematics at A-level, the selection of the three schools was based on four conditions:

1) A secondary school with Key Stages 3, 4 and 5
2) Willingness on the part of the school to take part in the study
3) The positions of the schools in the ranking based on points system devised by the Qualification and Curriculum Authority (QCA) in 2009
4) The academic calendar of the schools.

The ranking (Point 3 above), is an indication of the average point score per student at A-level of the particular year group. For example, A-level grade A is awarded 270 points. Based on these conditions, there were a total of seven secondary schools with sixth forms within the Local Authority (LA) in which the study was undertaken. The point scores of the sixth form schools within this Local Education Authority (LEA) range from 675 to 896. According to the rankings, I divided the secondary schools into three groups; Group 1 (850-896), Group 2 (795-850) and Group 3 (675-795). Negotiating access to the schools was done formally through letters to the Heads of the Mathematics departments through the Head Teachers of the selected schools, informing them of the nature of the study, the potential participants and inviting them to participate. The three secondary schools were selected based on the conditions above, one from each group of the ranking in other to give a fair representation.

The second stage of sampling involved the selection of teacher and student participants from each of the three schools. In each school, the study design anticipated that two A-level teachers (a male and a female) who had experience of teaching GCSE Mathematics and eight A-level students would be interviewed. The criteria for the selection of the eight students were based on gender (four boys and four girls); students studying A-level Mathematics and students who by virtue of their grade (A*-B) at GCSE, could have studied A-level Mathematics but chose not to. Out of the eight students from each school, four students (two boys and two girls) were studying A-level Mathematics and the other four (two boys and two girls) were students who had performed well in

GCSE Mathematics but were not studying A-level Mathematics. The choice of the number of participants involved with the interviews was influenced by the following factors:

1. Gender: equal representation of male and female
2. The schools' willingness and time at their disposal.

Involving more participants in the interviews than the numbers stated in Table 3 below would have resulted in taking more of the schools' time and therefore led to the likelihood of inconveniencing the schools. The questionnaires therefore complemented these perceived shortfalls. In total it was expected that 24 students and six teachers would take part in the interviews (details in Table 3). The number of questionnaires issued depended on each school and this is shown in Table 5 under Section 3.7.3.

The table below shows a summary of the expected and actual participants in the interviews:

Table 3: Summary of the expected and actual participants of the interview

School	Interviewee	Expected			Actual		
		Male	Female	Total	Male	Female	Total
A	Mathematics Teachers	1	1	2	1	1	2
	A-level Mathematics Students	2	2	4	2	2	4
	A-level students not studying A-level Mathematics but could have studied it	2	2	4	2	2	4
B	Mathematics Teachers	1	1	2	3	0	3
	A-level Mathematics Students	2	2	4	0	0	0
	A-level students not studying A-level Mathematics but could have	2	2	4	0	0	0

	studied it						
C	Mathematics Teachers	1	1	2	1	1	2
	A-level Mathematics Students	2	2	4	2	2	4
	A-level students not studying A-level Mathematics but could have studied it	2	2	4	3	3	6
	Total	15	15	30	14	11	25

The selection of the sample size for this study occurred at different stages of the study. Even though the selection of the three schools was based on the aim of the study, it also shows a proportional representation of all the A-level schools within the Local Authority. The aim of the study also became the basis for setting conditions for the selection of participants. The limits to the number of participants involved in the interview were influenced by factors such as: the objectives of the study; schools' academic timetables and the extent to which the schools were willing to be involved. I therefore agree with Robson's (2011) assertion that in qualitative research with interviews as the source of the data collection, the emphasis is on the depth of the information gathered and therefore the number involved may not be the issue, but the quality of their responses is of prime importance. Section 3.12 discusses issues arising from data collection.

3.7 Data Collection

The main aim of this section is to look at the data collection methods used in the study and the rationale for their choice. This section also looks at the meaning of the mixed methods approach and triangulation. These include the use of audio recordings for interviews and questionnaires and the rationale for the selection of each of them in relation to this study.

In this study, I have made use of three methods for data collection: the general statistical examination results in the UK for all subjects at GCSE and A-level from 2005 to 2011 published by the Joint Council for Qualifications (JCQ, 2012), interviews and questionnaires administered to teachers and students of participating schools. These decisions were made early in the planning stages of the research. The table below shows the focus of each method of data collection in addressing the research questions:

Table 4: Method of data collection in addressing the research questions

Research Question	Methods	Data generated	Approach to data analysis
1) Are there any differences in examination performance in Mathematics between boys and girls at GCSE?	Examinations results	Quantitative	Descriptive/ Inferential/ Statistics in perspective
2) Are there differences in the number of boys and girls pursuing A-level Mathematics?	Examinations results	Quantitative	Descriptive/ Inferential/ Statistics in perspective
3) What factors influence the choice of Mathematics at A-level?	Interview	Qualitative	Thematic coding analysis
	Questionnaires	Qualitative/ Quantitative	Thematic coding analysis
4) What are Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level?	Interview	Qualitative	Thematic coding analysis
	Questionnaires	Qualitative/ Quantitative	Thematic coding analysis

5) What are students' perspectives about gender and the choice of Mathematics at A-level?	Interview	Qualitative	Thematic coding analysis
	Questionnaires	Qualitative/ Quantitative	Thematic coding analysis

Three schools were involved in the study and the key informants were the teachers and the students in the schools. The timing of data collection depended on the availability of the key informants and the schools concerned. In all three schools the timings were different. In School A for instance, the teachers and students involved in the interviews were interviewed on the same day, while in School B, it was only the teachers who were available for the interviews. In School C, the teachers and the male students were interviewed on the same day and the female students were interviewed on a different day. This happened because the female students were on a field trip on the day of the first interviews. In all the three schools I was able to conduct the interviews myself, but I was not able to distribute the questionnaires to the respondents myself. I had to use the teacher representatives assigned to me by the schools to help with the distribution and collection of the questionnaires. I visited School A four times, School B three times and School C five times.

3.7.1 Mixed methods and Triangulation

The term "mixed methods" refers to the use of more than one source of evidence to find answers to the research questions (Yin, 2003; Stake, 1995). Rather than dwelling on a single specific question, Robson (2011) argues that mixed methods can be used to address different but complementary questions within a study. It can be used to clarify or explain the relationship that may exist between variables. This includes confirming or cross-validating the relationship.

The rationale for the choice of mixed methods in this study is to enhance the quality of the research by comparing and contrasting complementary data collection methods and to enable the triangulation of evidence (Yin, 2003).

Triangulation is the use of more than one strategy or method with the aim of substantiating the finding of the other (Yin, 2003; Robson, 2011). For example, triangulation can be carried out between the use of experiment and case study, qualitative and quantitative or interview and questionnaires, all within a particular research study with the view of corroborating the findings. Denzin (1988) identified four types of triangulation: data; observer; methodological and theory triangulations. In Denzin's (1988) view, "data triangulation" is the use of more than one method for data collection. "Observer triangulation" is using more than one observer in research study. "Methodological triangulation" is the use of both quantitative and qualitative approaches in a study and "theory triangulation" is the use of multiple theories in a study. Triangulation in either of the categories increases the reliability of both the process of gathering data and the final data collected (Yin, 2004). Data triangulation was employed in this study. Triangulation in the context of data collected from the questionnaire therefore serves to substantiate the data from the interviews (Chapter 5; Sections 5.1 and 5.5). The use of mixed methods does not necessary imply triangulation, but in this study, in order to triangulate both the questions for the interview and the questionnaire, the questions were structured to source for similar data. There was however no triangulation between the data on the general results in the UK at both GCSE and A-level and the interviews or the questionnaires.

3.7.2 Interview and Recording

Interviews are one of the main instruments for data collection in this study. In this sub-section, I focus on the rationales for the interview questions and the format of the interview: the rationale for interviewing teachers and students; the interview techniques used in the study; the recording of the interviews and when, where and how the interviews were conducted in the various schools. In planning for the interviews, I took into consideration the background of the schools; the objective of the interview; who to interview and why; the type and structure of the questions and ethical issues.

The choice of interviews as a method for the study was influenced by my ontological and epistemological assumptions, which I explained under Section

3.3. However, the choice of each of the questions for the interview (Appendix 1 and 2) was influenced by the main aim of the study, the research questions and the conceptual framework (Chapter 2). The interview questions for the Mathematics teachers (Appendix 2), sought to find out about:

1. Mathematics teachers' experiences with both genders at GCSE and A-level
2. Any differences they have identified in the teaching and learning of Mathematics for both genders
3. The influence they have in the decision making processes of students regarding the choice of A-level subjects and Mathematics in particular
4. Parental influence in the students' decisions.

The interview questions for students (Appendix 1) were intended to find out from them:

1. The factors they consider before choosing A-level subjects
2. What influences their choice or otherwise of A-level Mathematics
3. Their views about gender and Mathematics and the choices they make
4. Their general perception of Mathematics and what can be done to encourage more students to do A-level Mathematics.

Excluding follow-up questions, on average each teacher was asked 15 questions and each student 19 questions. Fraenkel and Wallen, (2008) identified four types of interview: structured; semi-structured; informal and retrospective interviews. Robson (2011), on the other hand, dwells on three types of interview: fully structured; semi-structured and unstructured interviews. The type of interview employed for both the teachers and the students in this study was the semi-structured interview. In a fully structured interview, the emphasis is on predetermined sets of questions (mostly closed questions), which the interviewer is expected to follow strictly (Kendall and Kendall, 2009). In my semi-structured interviews, I had already determined in advance a set of questions to be asked (Appendices 1 and 2). These questions were however subject to modification based on what I and the participant perceived to be appropriate. There were instances when the questions were reworded to make it clearer. In situations where a response to a question answers the next question, that question is omitted (Robson, 2011). Unstructured interviews are more informal and allow conversation to develop into an area of interest to the interviewer and the interviewee. The line of questioning may not involve any specific type of sequence (Fraenkel and Wallen, 2008). My choice of the semi-structured interview was due to the flexibility associated with it, which allows respondents to come out with points and issues that I had not already thought about in advance (Fraenkel and Wallen, 2008).

Two types of questioning were used in my semi-structured interviews; open-ended and closed questions. Open-ended questions enable the interviewee to respond with different possibilities and at what length they wish (Robson, 2011). I was not only interested in specific answers, but also in the breadth and depth of the interviewees' replies. This is what open-ended questions offer. Combining both open-ended and closed questions in the interviews made the interviewees feel at ease and to be keenly interested in the process. It also provided an opportunity for me to reflect and focus on any vocabulary or jargon used by the interviewees that I did not understand and for which I promptly sought clarification. Whilst open-ended questions gave me the richness of detail, closed questions gave me the opportunity to gather data that was easily comparable with other people's responses from either the questionnaires or interviews. In the event of missing out on information from closed questions, I was able to obtain clarification from an immediate or later response to an open-ended question.

The purpose of the research and the research questions helped me to define the limits of the participants for the study. The main reason for involving teachers in the interview was based on the fact that teachers have a lot of input to the students' academic work. Since part of the objective of the study is to determine the factors influencing students' choice of Mathematics at A-level, it is appropriate to understand the extent to which teachers influence the students' choices of subjects at A-level. Similarly, based on the focus of the study, it was also appropriate to interview A-level students who did well in GCSE Mathematics and either decided to study A-level Mathematics or otherwise.

The participants for the interview could have been widened to include groups such as GCSE top-set Mathematics students and parents. My inability to interview the GCSE top-set Mathematics students was more of an issue of ethics, as most of these students are under 16 years of age and consent could only be sought from their parents through the school. In order to minimise the inconveniences and maximise the time at my disposal as far as the schools were concerned, I decided not to interview the GCSE top-set Mathematics students but instead administered the self-completed questionnaires to them. It is very likely that parents play important roles in the students' choice of subjects at A-level, but with the emphasis of the study being on Mathematics, information about such roles was sought from the students and the teachers as shown in the questionnaires (Appendix 1-5). These decisions were influenced by Fraenkel and Wallen's (2008) suggestion that the choice of participants for an interview should be to find those who can offer the best insight and represent the full range of experiences and opinions. In this particular study therefore, the experience and opinions of the Mathematics teachers and the students involved could serve the same purpose as parents.

The recording of the interviews was done using both digital audio recorder and writing notes. A tape recorder is indispensable in an interview, but does not eliminate the need for taking notes (Robson, 2011). Taking notes about what is said may facilitate later analysis and help to locate important quotations from the audio recorded version (Fraenkel and Wallen, 2008). The main aim of taking the notes was to record facial expressions and any other forms of non-verbal communication which could not be recorded by the digital audio equipment. The recording of the notes also prevented unnecessary and/or unhelpful interference while the interviewee responded to a question. Instead, where a follow up question was needed as a result of what had just been said, I would quickly write it down and ask later on for clarification. More importantly, the decision to take notes made me more alert and focused on the process.

Using the audio recorder provided opportunity for better eye contact, rapport and accurate record of the conversation. It also allowed me to respond more rapidly and to interact well with interviewees. As result of audio recording the interviews, I have also had the opportunity to listen to the interviews several times and transcribe the exact words of the respondents.

In Schools A and C, the interviews were held in a designated interview room, whilst in School B, they were held in a vacant classroom. In all the schools, privacy and security were paramount, but the doors to the interview rooms were transparent. Having a transparent door is a security/safeguarding policy in all schools in the UK and it is meant to ensure that both students and staff are protected and with the door shut, confidentiality of the conversations within is assured. Table 3 shows the breakdown of participants from the various schools. In School A, the interviews took one day and were conducted just before the school went for the Easter break. There were female Mathematics teachers, but none were teaching A-level Mathematics. In School B, three male teachers were interviewed against the intended two. There were no female teachers teaching A-level Mathematics for me to interview in School B. In School C, interviews were held on different days; the first interviews involving the teachers and some of the students were held just before the end of the academic year, while the second part was held at the beginning of the next academic year. During the first part of the interview, I had the opportunity to be introduced to an A-level Mathematics class by the co-ordinator and with the objective of the study having been explained to them, students were asked to volunteer to be interviewed. The second part of the interview was slightly different, as the co-ordinators had informed the selected participants, who were mainly girls, prior to my arrival. This is why I had more participants in School C than the intended number. Other issues arising from the interview have been discussed under Section 3.12.

3.7.3 Self-Completed Questionnaire

Questionnaires were the other method of data collection employed in the schools. In designing the questionnaires (Appendices 3, 4 and 5), I took into consideration the following: the purpose of the research; the research questions; backgrounds of the respondents and ethical issues. A questionnaire can either be self-completed or completed by an interviewer (Robson, 2011). In this study, the questionnaires were self-completed as the respondents were expected to fill in their responses themselves. The design and choice of self-completed questionnaires was influenced by each school's academic timetable and the desire to get as many suitable respondents as possible. In all the three schools involved, there was a particular teacher chosen by the schools to co-ordinate and administer the questionnaires. This enabled the schools to distribute the questionnaires at their own convenience.

In the questionnaires, every effort was made to ensure that there were no double or triple-barrelled questions. In general, the questions sought to find out the following from the respondents: their backgrounds; knowledge and beliefs; experiences; opinions and feelings about Mathematics, gender and performance. Other questions sought to find out from the respondents what they had seen or heard about gender and Mathematics. The order of the questionnaires was important in this study, as the early questions, which were used to set the tone, were also intended to make the respondents more apprehensive (Kendall and Kendall, 2009). Similarly to the questions for the interview, the choice of each of the questions for the questionnaires (Appendix 1 and 2), was influenced by the main aim of the study, the research questions and the conceptual framework (Chapter 2).

In order to be able to triangulate the methods or data, almost all the information sought in the interviews was also asked for in the questionnaires. The use of self-completed questionnaires in addition to interviews was to eliminate any interviewer bias and more importantly, to ensure the anonymity of respondents. I acknowledge however the difficulty in knowing how well each respondent understood the question(s) and the difficulty of asking a follow-up question when further clarification to a response may be needed in the questionnaire survey. This is due to the fact that I was not present when the forms were completed in any of the three schools.

Unlike the interviews, the self-completed questionnaire respondents did not include teachers, but did include top-set students in GCSE Mathematics who were preparing for the GCSE examinations. The A-level Mathematics students and the A-level students who could have studied A-level Mathematics but chose not to do so also completed the questionnaires. The purpose of including top-set GCSE Mathematics students was to find out before they started the A-level programme what their motives or views for either wanting to study A-level Mathematics or otherwise were. The number of questionnaires printed and sent to the schools was decided in consultation with the representatives from each school.

The table below shows a summary of the distribution of the questionnaires:

Table 5: Summary of the distribution of the questionnaires

School	Distribution groups	Number of Questionnaires requested	Number of Completed Questionnaires	Number of uncompleted Questionnaires
A	A-level Mathematics Students	70	48	
	A-level students not doing A-level Mathematics but could have done it	25	17	5
	GCSE top-set in Mathematics	45	34	
B	A-level Mathematics Students	90	54	
	A-level students not doing A-level Mathematics but could have done it	30	6	

	GCSE top-set in Mathematics	45	27	8
*C	A-level Mathematics Students		55	
	A-level students not doing A-level Mathematics but could have done it		14	
	GCSE top-set in Mathematics		21	

**The school requested the use of an electronic copy of the questionnaires which they printed and distributed themselves.*

In Schools A and B, it was difficult to ascertain the exact number of uncompleted forms, since the co-ordinators could not account for all the questionnaires. In School C, since they opted to print the questionnaires themselves, it was also difficult to know the number of questionnaires returned uncompleted.

3.8 Pilot Study

The first stage of my data collection was the piloting of the interview questions and the questionnaires. My aims of piloting the study were: for rehearsal; to receive feedback; to identify any ambiguities and difficult questions; to aid my planning and to increase the reliability, validity and practicality of the questionnaires (Fraenkel and Wallen, 2008; Robson, 2011). Yin (2003) classifies the process of pilot study into two; pilot test and pre-test. He refers to the pilot test as the process used by the researcher to refine their data collection plans according to data content and procedures to be followed. The pre-test is a formal “dress rehearsal”, with the intended data collection strategy being followed as closely as possible to the intended setting of the research

(Yin, 2003). What Yin (2003) refers to as "pre-test" is rather seen by Fraenkel and Wallen, (2008) and Robson (2011) as "pilot study".

In piloting the questions used for the interview, the scene was set similarly to how I envisaged the actual interview scene would be. I used a watch to time myself throughout the period of the interview. One teacher and two students took part in the pilot interviews. On average, it took about 30 minutes to interview each of the participants. The piloting of the questionnaires involved three students from each of the categories. The students were asked to respond to the questionnaire about their understanding of each question. I recorded the time each student took to complete the questionnaires and because of my interest in the time it took for a questionnaire to be completed, I did not allow the respondent to take the questionnaires away to be submitted later. It took about 15 minutes to answer each questionnaire. All those who took part in the pilot were either friends or Church members and they did not hold back any critique. For instance, some drew my attention to similarities between questions, and as a result, I made appropriate deletions. In other cases, I needed to reword the question in order to clarify its meaning.

By listening to the recorded pilot interviews several times I became mindful of my own conscious and unconscious interferences regarding interviewees' responses to questions. Giving the respondents more time to complete their sentences and in some situations, asking them follow up questions for clarification helped me to avoid making assumptions about what the person intended to say, and I applied this procedure in the main interviews. I also noticed some repetition of answers from the interviewees, because their responses to some of the earlier questions addressed some of the questions that I asked later. I minimised this by listening more carefully, being alert and then skipping questions to which responses had already been made. As a result of the pilot, some questions were changed from either direct to indirect questions or vice versa depending upon how uncomfortable or hesitant the respondents seemed to be. All these changes arose from my perspective or from advice from respondents. In the case of the questionnaire, some respondents told me that in questions where they had options to choose, for example, if they intended to study A-level Mathematics or not, I gave them only two options "Yes" or "No". They felt that the response should also include the option of "Not certain". I therefore altered the questionnaire to accommodate this suggestion. As a result of the interview pilot study, ambiguous or confusing questions were re-phrased and over-long questions were shortened, while others were broken down into two questions, to ensure that only one point was focused on at a time. In the questionnaires, the respondents were not sure whether to circle or tick items. I initially thought that was not going to be a problem until after the pilot. My main challenge was achieving a balance between making sure the questionnaires did not look too bulky and ensuring clarity of the sentences without foregoing the advantage of questionnaires as an efficient method of collecting data.

3.9 Data Analysis

According to Robson (2011), data in its raw state does not speak for itself unless it is analysed and interpreted. Data analysis is a process of organising, ordering and extracting information from raw data (Kendall and Kendall, 2009). This process involves a lot of thinking and re-organising, with the view of understanding what the data contains and what it does not contain. The process and product of analysis offers the basis for interpretation (Yin, 2003). The data in this study came in the forms of published statistical examinations results, transcriptions of audio tapes of interviews and responses to the self-completed questionnaires.

3.9.1 Analysis of statistical examination results

As stated previously, the main sources of the statistical examination results for this study are the published examinations results from the Joint Council for Qualifications (JCQ) from June 2005 to June 2011. The analysis of the data is based on descriptive, inferential statistics and statistics in perspective. Descriptive statistics are used to describe the essential features of the data and provide a summary about the sample. This summary can be stated in the form of the mean, frequency and mode (Fraenkel and Wallen, 2008). They can also be represented by a bar chart, pie chart or histogram. Inferential statistics are used if the researcher is interested in making inferences based on the findings from the sample, while with descriptive statistics the researcher is only interested in the immediate data. With Inferential statistics however, the researcher is interested in conclusions that can be drawn beyond the immediate data. Using quantitative data to compare two or more groups with statistical parameters such as averages and frequencies helps to put the statistics in perspective. Fraenkel and Wallen (2008) suggest that quantitative data groups can be compared by using either percentages or frequencies. In their view, it is more appropriate to use graphical techniques before numerical to interpret the data.

Two forms of data were explored: GCSE and A-level Mathematics examination results. The first part of this analysis is the descriptive statistics, which involves exploring the GCSE results for Mathematics and Additional Mathematics. In exploring the data on GCSE Mathematics results, the limits were set to include grades B or higher. This is because throughout the interviews, it came to light that most sixth form schools use grade B as the cut-off point for students wanting to study A-level Mathematics. The data was recast to determine the total number of students who qualified to study A-level Mathematics for the various years. Based on this percentage, gender representations were determined for each year. All the information was then represented in graphical form. Drawing inference and putting the statistics in perspective involved the comparing of the data for different years. Grade limits were however not set for Additional Mathematics. This is because Additional Mathematics is an optional subject for students at GCSE and students without any grade in Additional Mathematics can still go on to do A-level Mathematics. But the essence of including Additional Mathematics in this analysis is because unlike compulsory Mathematics, students do it by choice. The aim was to find the proportional representation of males and females who took the subject for the various years and compare it with the numbers for compulsory Mathematics.

In exploring the A-level results, I first identified from the data the number of students who studied A-level Mathematics and Further Mathematics. The proportional representation of males and females was then determined. The derived data was then represented graphically before inferences were drawn. The analysis of statistical examination results is located in Chapter 4.

3.9.2 Analysis of interviews and self-completed questionnaires

The main approach for analysing the data from the interviews was based on Thematic Coding Analysis (TCA) (Silverman, 2011). The self-completed questionnaires were however analysed with both TCA and quantitative analysis. Robson's (2011) assertions that the flexibility of TCA provides the means to summarise key features of large amounts of qualitative data have influenced my choice of this approach. Another reason for the choice of TCA is the ability to develop descriptive accounts, which can be refined where necessary (Silverman, 2011).

3.9.2 (i) Thematic Coding Analysis(TCA): interviews and Self-completed questionnaires

Based on the TCA, there were five stages involved with the analysis. Firstly the familiarisation stage, which involved the transcribing of the digitally recorded tapes and reading and re-reading of informants' responses to the self-completed questionnaires (Robson 2011). The next stage involved generating codes; this is concerned with organising data into meaningful groups. In the study, this was guided by the research questions and previous research findings. This led to the third stage, involving the identification of the main themes (Silverman, 2011). The transcribed interview and self-completed questionnaires were examined critically to identify similarities, differences and any recurring information to establish themes. According to Silverman (2011), the main purpose of a theme is to capture important patterns in the data in relation to the research questions. In this study therefore, the aim of the study and the research questions influenced the theme selection. This formed the basis for identifying themes that could address the research questions and could also link to the literature in other to confirm or challenge previous findings and the theoretical framework. The fourth stage involved the contraction of the thematic framework and making comparisons. This stage of the study focused on finding out how the themes identified in the third stage could fit into each other to form one network. This led to the creation of sub-themes within each identified theme (Robson 2011). The final stage involved the integration and interpretation of the data. This aspect of the analysis involved making comparison between the various views of the informants in the study by exploring, summarising, describing and interpreting identifiable patterns (Robson 2011).

In employing the TCA, genuine categories were discovered and given labels, which were then related to a theme. Sub-categories were created under categories. For example, in the questionnaires, female students who were not studying A-level Mathematics but who felt that Mathematics had nothing to do with gender were given codes. In this scenario, the main categories were males and females not studying A-level Mathematics. The sub-categories were the female students who felt that Mathematics had nothing to do with gender and those who held contrary views. In charting, I kept on arranging and rearranging my categories and sub-categories according to themes which hitherto were not seen to have had any bearing on the aim of the study, but which have now become important (Fraenkel and Wallen, 2008; Robson 2011).

3.9.2 (ii) Quantitative (Statistical) analysis of self-completed questionnaires

The quantitative analysis of the self-completed questionnaires was based on descriptive statistics, inferential statistics and statistics in perspective as described in 3.9.1. The main reason for analysing the self-completed questionnaires quantitatively in addition to TCA was to enhance trustworthiness (Section 3.11). The frequency of occurrence of some of the themes and sub-themes identified from the TCA formed the basis of the quantitative analysis, which included the use of pie and bar charts (located in Chapter 5/Section 5.1).

3.10 Ethical Considerations

Research ethics involve the application of professional codes and moral rules in a research study (Robson, 2011). Ethical principles are therefore expected to influence the whole study, including choice of strategy and methods of collecting and analysing data. They also affect the mode of publication or reporting. Ethical principles are very important to this research, because they are concerned with confidentiality of research data, the participants and avoiding issues of participants feeling deceived (Fraenkel and Wallen, 2008). Bassey (1999) explains that research ethics should seek to respect democracy, truth and the person. In a democratic country, I have the freedom to investigate, to question and to receive information, but these activities must not endanger others. As a researcher, respect for the truth means a lot to me and as such, in the process of collecting, analysing and reporting data, every effort was made to report the truth (Bassey, 1999). According to Robson (2011) there should be a careful balance between the researcher's right to know and the participant's right to privacy. Respect for participants was very important to me in this study. While every effort was made to either remove or re-word questions that may have infringed on the person's rights during the piloting stages, I also made participants aware that they were not under any compulsion to answer every question.

This research study was conducted in accordance with The University of Sheffield's ethical review principles (Appendix 9). These principles have some similarities to Bassey's (1999) assertions and the *Ethical principles for conducting research with human participants* by the British Psychological Society (Robson, 1993, p. 470). The study was approved by the University's Ethics Committee before the fieldwork commenced. Participants in the schools also signed consent forms of their own accord. This was after they had been given letters requesting their participation and the assurance of confidentiality had been provided. The letters also spelt out the aims and objectives of the research. Subsequently, all participants were also informed of the aims and objectives of the study. The participants were also informed of their rights to opt out if they so wished at any period of the research study. The participants signed and kept copies of consent forms before all interviews commenced. The process of piloting the study also helped eliminate any questions that came up as unethical. I had my Disclosure Barring Services (DBS) certificate checked by all the schools, without which I would not, by law, have been permitted to interview secondary school students.

3.11 Trustworthiness of the study

According to Yin (2003), it is necessary to test for validity and/or reliability in the research study. However, the data collection for this study is from two sources; a primary qualitative and secondary quantitative data (i.e. the use of statistical data from the JCQ). Since this is a case study, the concepts of reliability and validity are not as vital as in surveys and experiments (Bassey, 1999). At the same time, the source of the secondary data for this study is statistical data from JCQ the membership of which is comprised of credible and reputable examination boards, hence enhancing the validity and reliability of the quantitative data (Robson, 2011). The trustworthiness of the qualitative data of this study is guided by Guba's (1985) four criteria for establishing trustworthiness in a qualitative research which is based on credibility, transferability, dependability and confirmability of the research.

The credibility of a case study depends on many factors, including the adoption of appropriate and well documented research methods (Yin, 2003). It is in line with this that the process of collecting data through interviews and the use of self-completed questionnaires has been well documented under this chapter. Credibility in this study was ensured through the process by which the questions used (Appendix 1-5) in both the interviews and the self-completed questionnaires were developed (Sections 3.7.2 and 3.7.3). The processes also include how sampling (Section 3.6) and piloting (Section 3.8) were done. Another aspect of enhancing the credibility of this study is the use of both interviews and self-completed questionnaires (triangulation) to source for similar information (Guba, 1985). There were also regular debriefing sessions between me, the researcher, and my supervisor (Shenton, 2004). The positionality of a researcher plays an important part in the issue of credibility. In Section 3.3 the position of the researcher has been explained and every effort was made to avoid researcher bias (Wellington et. al., 2005).

According to Yin (2003) external validity is associated with identifying the extent to which the outcomes of a study can be applied to other circumstances. Bassey (1999) argued that the detailed contextual nature of case study makes it difficult to examine it under external validity. Similarly, transferability under case study is about examining the prospect of transferring the findings of a study to other similar situations (Guba, 1985). Because of the difficulty in transferring such findings, Guba proposes that transferability in case study should be about the researcher providing detailed descriptions of the phenomenon under investigation to allow recipients to make the final decision about the transferability of the findings. Based on Guba's suggestion, the transferability of this study is improved by the detailed description of the methodology, including how data was derived and analysed in this chapter.

In the view of Lincoln and Guba (1985), there are few differences between dependability and credibility. Similar to establishing credibility, employing multiple sources of evidence in data collection and giving key informants the opportunity to review case study report enhances dependability (Yin, 2003). In this study, I have explored multiple sources of data collection and the interview transcriptions were returned to participants for their comments.

According to Shenton (2004) the concept of confirmability in enhancing trustworthiness is associated with the researcher taking the necessary steps to ensure that the findings of the study are the results of the views and experiences of informants and not based on the preferences of the researcher. In the view of Lincoln and Guba (1985) documentation of anything that could emphasise or reduce researcher bias are all processes of ensuring confirmability. It is based on Shenton, Lincoln and Guba's (1985) views that in this study, procedures such as recording and transcribing interviews were strictly followed. The use of triangulation is also a means of minimising researcher bias. Admission of my position as a researcher and the acknowledgement of the shortcomings of the study all contribute to improving the confirmability of my findings (Shenton, 2004).

In conclusion, the key to enhancing trustworthiness in this study is the meticulous documentation of all the stages involved. This is the main purpose of this chapter on methodology and methods. It is also about drawing conclusions based of evidence from the study and giving readers enough information to decide on the credibility, transferability, dependability and confirmability of the study.

3.12 Issues arising from Data Collection and Analysis

3.12(i) Data Collection: Interview

Since all the A-level students were in their final year and they were less than a month away from completing their final examinations, it was difficult to request any follow-up to the interview for any clarification. School B did not allow me to interview their students because the school would have had to apply for a DBS check on my behalf and they were not willing to do that despite my showing them my copy of the DBS check I already held. I did not understand their reasoning, because based on the same DBS certificate, I had previously taught in the same school for three consecutive days. The students however responded to the self-completed questionnaires, which made up for my inability to interview the students.

3.12(ii) Data Collection: Questionnaires

The use of the co-ordinators from the schools was a good idea, but there were instances when co-ordinators did not follow some of the procedures for documenting the data as I had instructed. For example, I requested that the co-ordinators take an inventory of the number of questionnaires they gave out and the number that was returned, which was not done.

In all the three schools, teachers complained of the difficulty in finding a sizeable number to respond to the questionnaires for A-level students who could have done A-level Mathematics but decided not to. They explained that unlike GCSE top-set Mathematics and A-level Mathematics students, who are already in a class group, for this particular group they needed to either go through students' results to find them or keep asking from different A-level class groups, which would have taken too much time.

3.13 Conclusion

The process of writing this chapter on the methodology and method has been about reflecting on my choices and rationale for the processes that I went through in getting this research study completed. Limitations were identified at different stages of the study, associated with the design, sample size, informants and the process of data collection. Limitations included my inability to involve parents and GCSE students in the design of the research. In addition to time constraints in the schools, some of the students who were part of my original design could not be interviewed. Lack of access to schools to observe teachers' interactions with students during some of the open days was also a limitation, as it could have enabled me to understand more about the extent to which teachers influence the choices students make. Another limitation which affected the sample size was the difficulty in identifying students who could have studied A-level Mathematics but chose not to.

The strength of this study is in its combination of qualitative data and quantitative data in the design to address the research questions. Secondly, the qualitative data came from two sources; the semi-structured interviews and the questionnaires, with the aim of enhancing reliability and validity. Finally, the use of secondary data has helped in addressing Research Questions 1 and 2.

CHAPTER FOUR: Data Analysis 1

The main purpose of this chapter on data analysis is to present, analyse, interpret and evaluate Mathematics examination test results at both GCSE and GCE A-levels from secondary schools in the UK. The results under scrutiny extend from 2005 to 2011 and were published by the Joint Council for Qualifications (JCQ, 2012). The first part of this chapter looks at the analysis of GCSE examination results in Mathematics and Additional Mathematics. Mathematics at GCSE level is compulsory for all students in the UK, whilst Additional Mathematics is optional. The purpose of Additional Mathematics is to provide extra in-depth Mathematics study for those students who require knowledge of Mathematics beyond the GCSE Mathematics higher tier (Council for the Curriculum Examinations and Assessment, 2004). The second part of the chapter focuses on an analysis of examination results at A-level in Mathematics and Further Mathematics. Further Mathematics is an extension of A-level Mathematics.

The aim of this analysis is also is to respond to my first two research questions:

1. Are there any differences in examination performance in Mathematics between boys and girls at GCSE?

2. Are there differences in the number of boys and girls pursuing A-level Mathematics?

The purpose of quantitative data analysis can either be exploratory or confirmatory. Exploratory data analysis seeks to explore the data with the view of finding out or understanding the important characteristics of the data. Confirmatory analysis, on the other hand, seeks to establish whether a theory or a prediction is confirmed (Robson, 2011). The main aim of analysing the examination results in this study is exploratory, with the view of finding out what the data reveals about gender, participation and performance in Mathematics. The approaches to analysing the data are based on descriptive and inferential statistics and statistics in perspective. In this study, descriptive statistics are used to describe the essential features of the data and provides a summary about the data. This summary is stated in the form of the mean, frequency and mode (Fraenkel and Wallen, 2008). The summaries have also been represented in the form of tables and bar charts.

Secondly, inferential statistics also played a role in this data analysis. This is based on Fraenkel and Wallen's (2008) suggestion that inferential statistics can be used if the researcher is interested in making inferences based on the findings from the sample. With descriptive statistics, I am interested in what the immediate data shows; including the identification and representation of differences in participation and performance by gender in Mathematics shown by any statistical pictorial diagrams that explain the data clearly. With the inferential statistics, I am interested in the conclusions that can be drawn or inferred beyond the descriptive statistics. Using quantitative data to compare two or more groups with statistical parameters such as averages and frequencies also helps to put the statistics in perspective. Drawing inferences and putting the statistics in perspective involves the comparing of the data for different years (Fraenkel and Wallen, 2008). Comparing GCSE and A-level Mathematics therefore helps to make inferences and put the statistics in perspective. Fraenkel and Wallen (2008) suggest that quantitative data groups can be compared by using either percentages or frequencies. Fraenkel and Wallen's (2008) view is it is more appropriate to use graphical techniques before numerical to interpret the quantitative data. In this study therefore, inferential statistics and statistics in perspective are also used in analysing GCSE and A-level Mathematics results.

4.1 Analysis of GCSE Mathematics and Additional Mathematics examination results by gender

The data and the subsequent graphs in this section have been derived from the statistics of results published by the Joint Council for Qualifications (JCQ, 2012) and consist of descriptive statistics, which involved exploring the GCSE results for Mathematics and Additional Mathematics. The section consists of the analysis of GCSE Mathematics and GCSE Additional Mathematics performance in terms of proportional gender representation and of performance, as well as the number of students who took part in GCSE Additional Mathematics. Table 6 below shows the number of students who sat for GCSE Mathematics and

Additional Mathematics by gender and their performance from 2005 to 2011. The JCQ data in Table 6 provides the cumulative percentages of the various grades. For instance, from Table 6, in 2011, the cumulative percentage of male students with grade B in Mathematics is 32.2%. This represents the percentage of male who had grades A*-B and not just grade B only. Similarly from the table in 2010, 87.4% of the female students had grades A*-E in Mathematics.

Table 6: GCSE Mathematics and Additional Mathematics examination results from 2005 to 2011

Cumulative Percentage in Mathematics and Additional Mathematics by Grade from 2005 to 2011 (Source: JCQ)

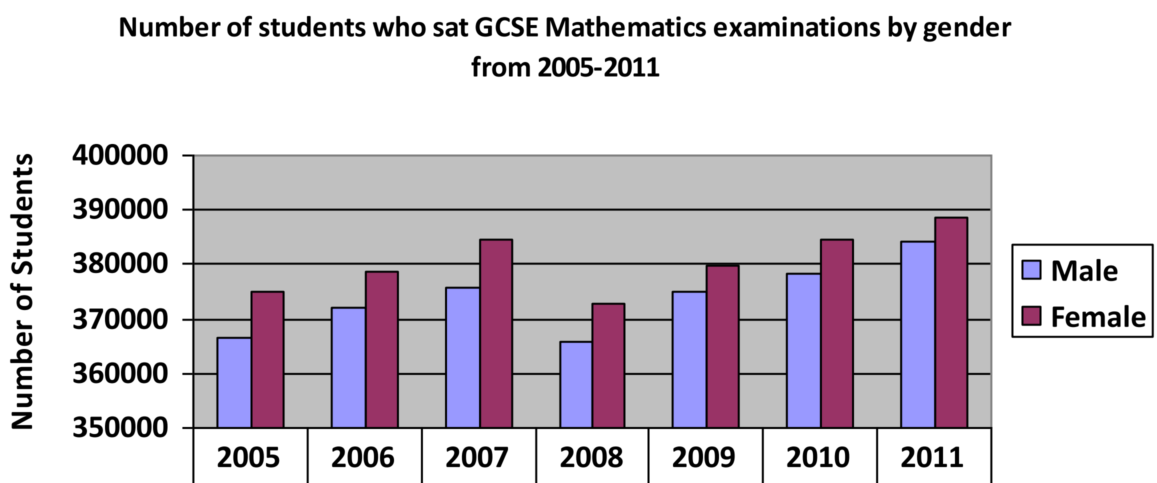
				Cumulative percentage by grade																			
			Number Sat	A*	A	B	C	D	E	F	G	U		Number Sat	A*	A	B	C	D	E	F	G	U
Mathematics	2011	Male	384258	5.3	16.6	32.2	58.9	75.7	86.5	94.3	98.4	100.0	**Additional Mathematics**	7107	12.7	32.8	53.3	75.7	85.6	91.8	95.8	97.5	100.0
		Female	388686	5.2	16.5	31.9	58.6	76.5	87.4	94.6	98.4	100.0		6175	9.1	26.7	46.0	70.8	82.6	90.5	95.3	97.7	100.0
	2010	Male	378305	5.1	16.4	32.5	58.6	76.3	87.0	94.4	98.3	100.0		9033	13.0	30.4	50.3	74.2	84.7	92.4	96.2	98.2	100.0
		Female	384487	4.9	16.0	31.8	58.3	76.8	87.4	94.6	98.3	100.0		8150	8.7	24.6	42.6	68.6	82.2	91.7	96.2	98.3	100.0
	2009	Male	375053	4.8	15.5	31.2	57.6	75.8	86.9	94.1	98.1	100.0		9914	10.8	26.2	44.3	69.2	81.4	90.0	95.2	97.9	100.0
		Female	379685	4.5	15.2	30.6	56.8	75.9	87.2	94.2	98.1	100.0		8851	7.3	21.3	39.0	66.7	80.7	90.2	95.6	98.2	100.0
	2008	Male	365806	4.4	14.1	30.2	55.8	73.8	85.4	93.3	97.3	100.0		8771	9.3	25.5	46.7	70.7	82.4	89.6	94.2	97.3	100.0
		Female	372645	4.8	14.8	31.3	56.8	74.9	86.5	93.9	97.5	100.0		8202	7.1	22.0	42.0	67.1	80.8	89.4	94.9	98.1	100.0
	2007	Male	375877	4.1	13.7	30.8	54.6	72.0	85.2	92.7	96.0	100.0		5214	12.8	33.8	60.0	79.7	87.8	92.3	95.4	97.5	100.0
		Female	384422	4.1	13.8	32.1	55.8	73.8	86.6	93.4	96.3	100.0		4579	9.8	28.5	54.2	77.9	86.6	92.1	95.9	97.7	100.0
	2006	Male	371875	4.2	13.2	30.2	53.5	71.1	84.6	92.5	96.0	100.0		1709	16.3	41.2	70.5	89.8	94.5	96.5	96.5	96.5	100.0
		Female	378695	4.1	13.2	31.4	55.0	73.7	86.7	93.5	96.4	100.0		1573	16.1	44.1	74.4	91.3	96.6	97.8	97.8	97.8	100.0
	2005	Male	366488	4.2	12.9	29.7	52.5	70.2	84.0	92.4	96.1	100.0		1732	15.3	39.7	69.8	89.2	95.3	97.1	97.1	97.1	100.0
		Female	374934	4.0	13.0	31.3	54.4	72.5	85.7	93.2	96.4	100.0		1524	16.0	45.3	74.5	92.1	96.3	97.9	97.9	97.9	100.0

4.1.1 Analysis of GCSE Mathematics examination results by gender

In this sub-section of the analysis, the aim is to determine the number of students who by virtue of their grades qualified to pursue A-level Mathematics by gender. In exploring the data on GCSE Mathematics results, the limits were set to exclude grades below grade B. The focus therefore is on grades A*-B. This is because the minimum requirement for doing A-level Mathematics at all the schools involved in this study is grade B and subsequent study of the prospectus of other secondary schools in different parts of UK reveals a similar trend. I do however acknowledge that there are further education colleges who have courses in place to develop the mathematical skills of mature students or students who obtained grade C in higher GCSE Mathematics before being allowed to do A-level Mathematics. The Foundation of Advanced Mathematics (FOAM) is an example of such a course for students in some of the colleges (MEI, 2001).

The importance to this study of analysing the GCSE examination results in Mathematics by gender is to determine if there are gender differences in the number of students who qualified at GCSE level with a grade which would enable them to study A-level Mathematics if they so wished. Two graphs, Figure 2 and Figure 3, have been derived from Table 6 and they are based on the GCSE Mathematics results. Figure 2 shows by gender the number of students who took GCSE Mathematics from 2005 to 2011.

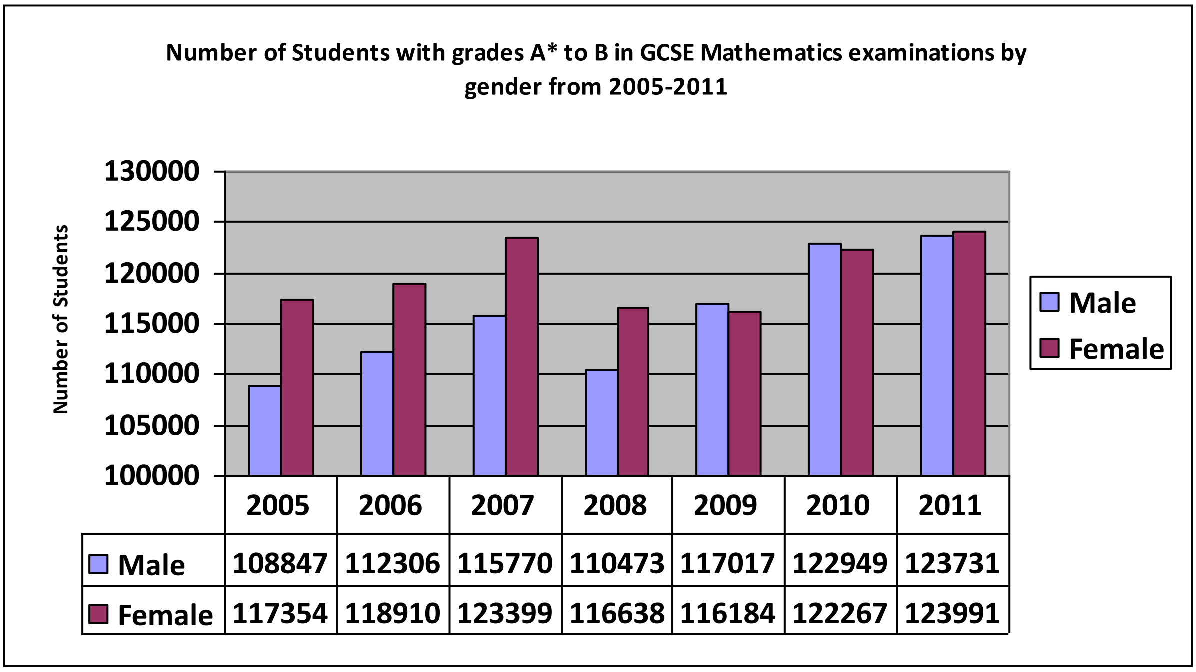
Figure 2: Students who took GCSE Mathematics examinations from 2005 to 2011.



	2005	2006	2007	2008	2009	2010	2011
Male	366488	371875	375877	365806	375053	378305	384258
Female	374934	378695	384422	372645	379685	384487	388686

The graph in Figure 3, which was derived from Table 6, shows the number of students with grades A*-B from 2005 to 2011 by gender. The JCQ data which provided the cumulative percentage of the various grades was used to determine the actual number of students who had the various grades. The following example shows how the data was managed to arrive at the data used for plotting the graphs. For example, from Table 6, in 2011 the number of female students who sat for the Mathematics examination was 388,686 and the cumulative percentage at B (i.e. A*- B) from table 6 is 31.9%. The total number of girls who achieved A*-B is therefore 0.319 x 388,686 = 123,990.834 (This number is rounded up to the nearest whole number which is 123,991). Similar calculations have been carried out to obtain the figures used in plotting the graph (Figure 2).

Figure 3: Students with grades A*-B in GCSE Mathematics examinations from 2005-2011



From Figure 2, between 2005 and 2008 more girls than boys qualified to study A-level Mathematics. In 2005, girls exceeded boys by 3.8%, in 2006 by 2.8%, in 2007 by 3.2% and in 2008 by 2.8%. In 2009 and 2010 there was a shift in favour of boys; in 2009 boys exceeded girls by 0.4% and in 2010 the difference was even less, 0.2%. In 2011 however, there was another shift of 0.2% in favour of girls. From this analysis, we can see that from 2005 to 2008 more girls than boys qualified to study A-level Mathematics, whereas 2009 and 2010 more boys than girls qualified to study A-level Mathematics. The situation changed again in 2011, when more girls than boys qualified to study A-level Mathematics.

4.1.2 Analysis of GCSE Additional Mathematics examination results by gender

As previously stated, GCSE Additional Mathematics is not a compulsory subject. The aim therefore for analysing the data on Additional Mathematics is to determine whether the non-compulsory nature of the subject is related to participation and performance by gender. Since the main aim of this study is to investigate factors influencing the choice of Mathematics at A-level from a gender perspective, the significance of analysing the data on Additional Mathematics to this study is that knowing students' participation and performance in a non-compulsory Mathematics subject could provide evidence about students' choice or otherwise of A-level Mathematics. This is because like GCSE Additional Mathematics, A-level Mathematics is not a compulsory subject and therefore students' free will is involved in their choice.

4.1.2(i) Comparison of students' participation in GCSE Additional Mathematics by gender

Figure 4 shows by gender the number of students who took GCSE Additional Mathematics from 2005 to 2011. The data used for this graph was derived from Table 6 under Additional Mathematics.

Figure 4: Students who studied Additional Mathematics

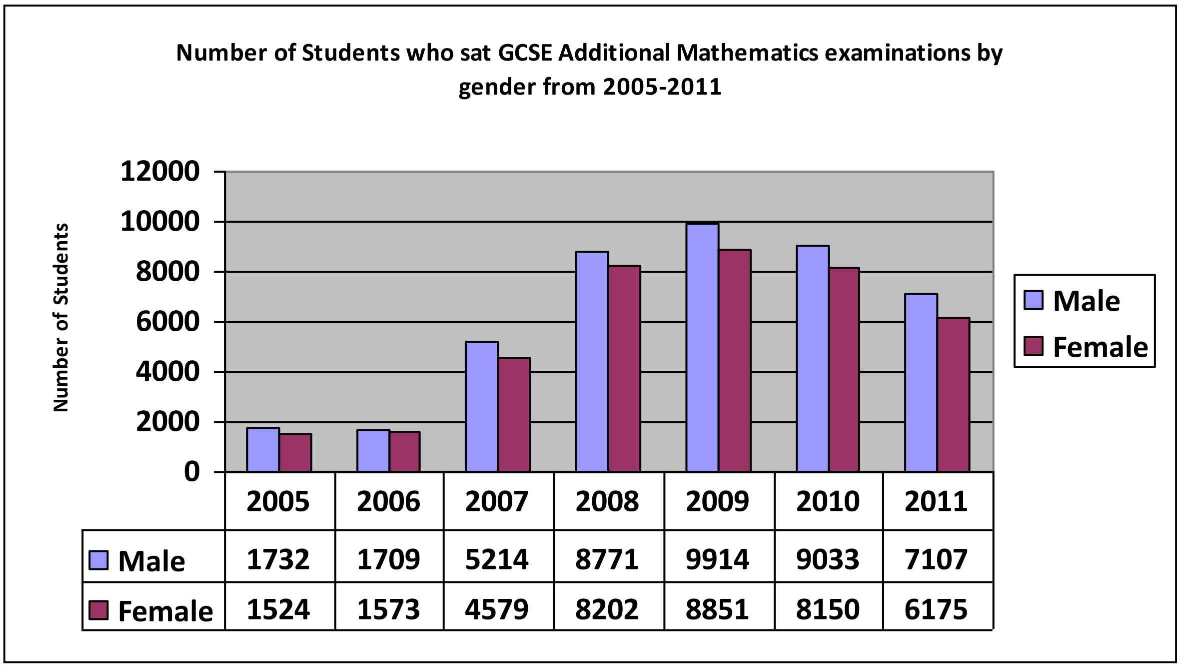


Figure 4 shows consistently that more males than females have studied Additional Mathematics. Between 2005 and 2006 there was 1.3% decline in participation for boys and 3.2% rise in participation for girls. Between 2006 and 2007 there was a 205% rise in participation for boys and 191.1% rise in participation for girls. The table below (Table 7) shows the changes in participation between 2005 and 2011. The following example shows how the percentage change from one year to another was calculated. For example, from 2005 to 2006, the number of male students who studied Additional Mathematics decreased by 23 students (i.e. 1732-1709=23). The percentage change is (23/1732) x 100%=1.3. Negative signs associated with the percentages in Table 7 below mean there was a decrease in the number of students from the previous year.

Table 7: Students' participation in GCSE Additional Mathematics examinations from 2005 to 2011

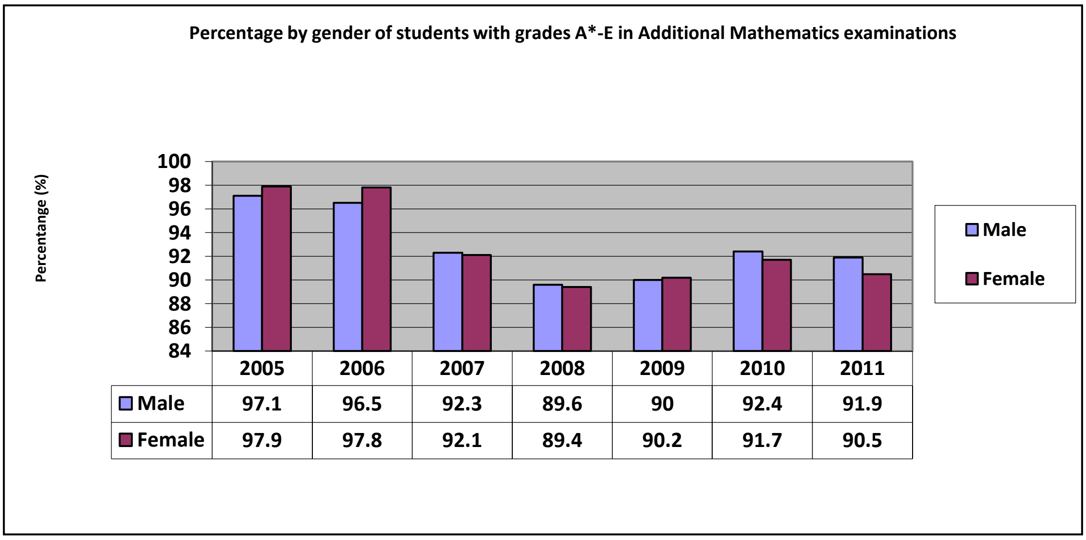
	Percentage change in participation in Additional Mathematics by gender from 2005 to 2011					
	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Male	-1.3%	205.0%	68.2%	13.0%	-8.9%	-21.3%
Female	3.2%	191.1%	79.1%	7.9%	-7.9%	-24.3%

Even though the graph in Figure 4 seems to suggest that if Mathematics is not compulsory it will attract more boys than girls, other factors may have contributed to this trend. A careful analysis of Figure 4 and Table 7 shows a gradual rise in participation in GCSE Additional Mathematics in general from 2005 to 2009, but just after 2009 participation began to gradually drop. This decline in participation was not peculiar to any particular gender. Between 2009 and 2010, the decline in participation was higher in boys and from 2010 to 2011 the decline was higher in girls (as shown in Table 7). Therefore, based on participation (Figure 4), the conclusion could be drawn that Additional Mathematics attracts more boys than girls, but based on Table 7, the general decline in participation suggests that there are other factors that need to be considered.

4.1.2(ii) Comparison in performance in GCSE Additional Mathematics by gender

Figure 5 shows the percentage of students with grades A*-E in Additional Mathematics by gender. Like Figure 4, Figure 5 was derived from Table 6. The calculation of the percentages is based on the individual gender group. For example, from Table 6 the 97.1% for male students who had grades A*-E in 2005 represents 97.1% of the total number of male students (1732) who sat for GCSE Additional Mathematics and not 97.1% of the overall number of students who sat for Additional Mathematics. The main reason for focusing on proportion based on individual gender groups but not in relation to the total number of students is that I have already established under section (4.1.2(i)) that differences do exist between the number of males and females who sat for Additional Mathematics. The emphasis is now on determining among the males and females the percentage of each who achieved grades A* to E.

Figure 5: Students' performance in GCSE Additional Mathematics examinations



One of the aims of this study is to find out whether differences exist in performance between both genders. The main aim of this study is to investigate the factors influencing the choice of Mathematics at A-level, Therefore, investigating the performance by gender in Additional Mathematics, which is not a compulsory subject at GCSE level, is significant to this study because A-level Mathematics is also not compulsory.

The performance (grades A*-E) between genders changes in different years. In 2005, Figure 5 shows that 97.9% of the girls achieved grades A*-E against 97.1% of the boys. In 2006 and 2009 the proportion of girls gaining A*-E was greater than boys, but in 2007, 2008, 2010 and 2011 the proportion of the boys who had A*-E was larger. Figure 5 shows almost equal performance among both boys and girls. In 2005 for instance, 97.1% of the males obtained A*-E against 97.9% of the females. This trend could be an indication that performance may not necessarily be a factor influencing the decisions of girls in the choice of Mathematics. This is because the performance of girls in compulsory Mathematics should have encouraged more girls to study Additional Mathematics, but this is not reflected in the earlier graph (Figure 5).

4.2 Analysis of A-level examination results in Mathematics and Further Mathematics by gender

The main aim of this study is to investigate from gender perspective factors influencing the choice of Mathematics at A-level and therefore analysing A-level Mathematics and Further Mathematics is very significant to this study. Similarly to Table 6 above, the data and the subsequent graphs in this section have been derived from the statistics of results published by the Joint Council for Qualifications (JCQ, 2012). This section of analysis consists of descriptive statistics, which involves exploring the GCE A-level results for Mathematics and Further Mathematics. This section evaluates students' participation and performance by gender in A-level Mathematics and Further Mathematics from 2005 to 2011. Exploring the A-level results involves firstly, identifying from the data below (Table 8) the number of students who pursued A-level Mathematics and Further Mathematics. The proportional representation of male and female students was then determined. The derived data was then represented graphically before inferences were drawn. Table 8 shows the number of students who sat for GCE A-level Mathematics and Further Mathematics examinations by gender and their performance from 2005 to 2011. The grading system at A-level in UK changed after 2009 and grade A* was subsequently introduced. The absence of the number of students under A* grade from 2005 to 2009 does not mean that no students were awarded A*; rather that A* was not included in the grading system during the period stated. This was not peculiar to Mathematics only, but to all A-level subjects. These changes did not have any effect on this analysis.

Table 8: Students' Performance in A-level Mathematics and Further Mathematics examinations from 2005 to 2011

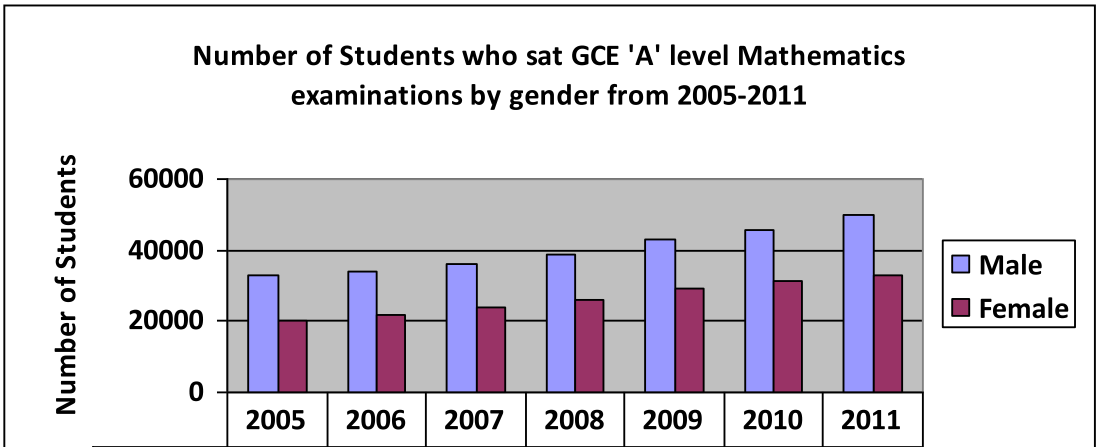
			Cumulative Percentage in A-level Mathematics and Further Mathematics by Grade from 2005 to 2011																
				Cumulative percentage by grade															
			Number Sat	A*	A	B	C	D	E	U		Number Sat	A*	A	B	C	D	E	U
Mathematics	2011	Male	49828	18.2	44.5	65.6	80.9	91.4	97.4	100.0	Further Mathematics	8455	27.8	57.7	78.7	89.2	95.1	98.2	100.0
		Female	33167	17.1	44.9	67.7	83.3	93.1	98.0	100.0		3832	26.9	57.6	79.6	90.0	95.5	98.6	100.0
	2010	Male	45737	17.3	44.3	65.3	80.5	90.8	97.1	100.0		7954	30.7	58.7	78.6	89.4	94.9	98.2	100.0
		Female	31264	17.0	45.5	68.2	83.6	92.8	97.9	100.0		3728	28.2	58.9	78.9	90.8	96.3	98.7	100.0
	2009	Male	43055		44.2	65.2	80.4	90.9	97.0	100.0		7190		58.6	78.1	88.7	94.6	98.1	100.0
		Female	29420		46.6	68.8	83.7	92.8	97.8	100.0		3283		57.2	78.6	91.1	96.2	98.5	100.0
	2008	Male	38719		42.7	64.3	79.9	90.5	96.9	100.0		6325		57.0	76.9	88.3	94.2	97.3	100.0
		Female	25874		46.0	68.7	83.4	92.7	97.7	100.0		2766		58.7	79.7	90.3	95.9	98.5	100.0
	2007	Male	36036		42.6	63.4	79.2	90.1	96.5	100.0		5556		57.1	76.5	88.1	94.7	98.3	100.0
		Female	24057		45.5	67.7	82.8	92.8	97.8	100.0		2316		56.2	78.4	89.3	95.5	98.5	100.0
	2006	Male	34093		41.7	62.3	77.9	89.2	96.5	100.0		5106		56.3	75.7	87.2	94.3	97.9	100.0
		Female	21889		46.2	68.1	83.1	92.3	97.5	100.0		2164		58.2	78.1	89.5	94.9	98.7	100.0
	2005	Male	32719		39.0	59.8	75.9	87.7	95.2	100.0		4238		57.2	74.7	85.7	93.1	97.0	100.0
		Female	20178		43.6	66.0	81.3	91.6	97.1	100.0		1695		60.2	77.8	88.8	93.7	97.4	100.0

(Source: JCQ)

4.2.1(i) Comparison of students' participation in A-level Mathematics examinations by gender

Figure 6 shows the number of students who took GCE A-level Mathematics from 2005 to 2011 by gender. The data for this graph was derived from Table 8.

Figure 6: Number of students' participation in A-level Mathematics examinations (2005-2011)



	2005	2006	2007	2008	2009	2010	2011
Male	32719	34093	36036	38719	43055	45737	49828
Female	20178	21889	24057	25874	29420	31264	33167

Figure 6 shows that between 2005 and 2011 more boys than girls took A-level Mathematics examinations. In 2005, females represented 38.1% of the total number of students who sat A-level Mathematics examinations. In 2006, females were 39.1%, in 2007 (40.0%), in 2008 (40.1%), in 2009 (40.6%), in 2010(40.6%) and in 2011 (40.0%).The graph also shows a consistent increase in participation by both genders. Table 9 shows the percentage change in participation in A-level Mathematics from 2005 to 2011.

Table 9: Changes in participation in A-level Mathematics by gender from 2005 to 2011

	Percentage change in participation in A-level Mathematics by gender from 2005 to 2011					
	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Male	4.2	5.7	7.4	11.2	6.2	8.9
Female	8.5	9.9	7.6	13.7	6.3	6.1

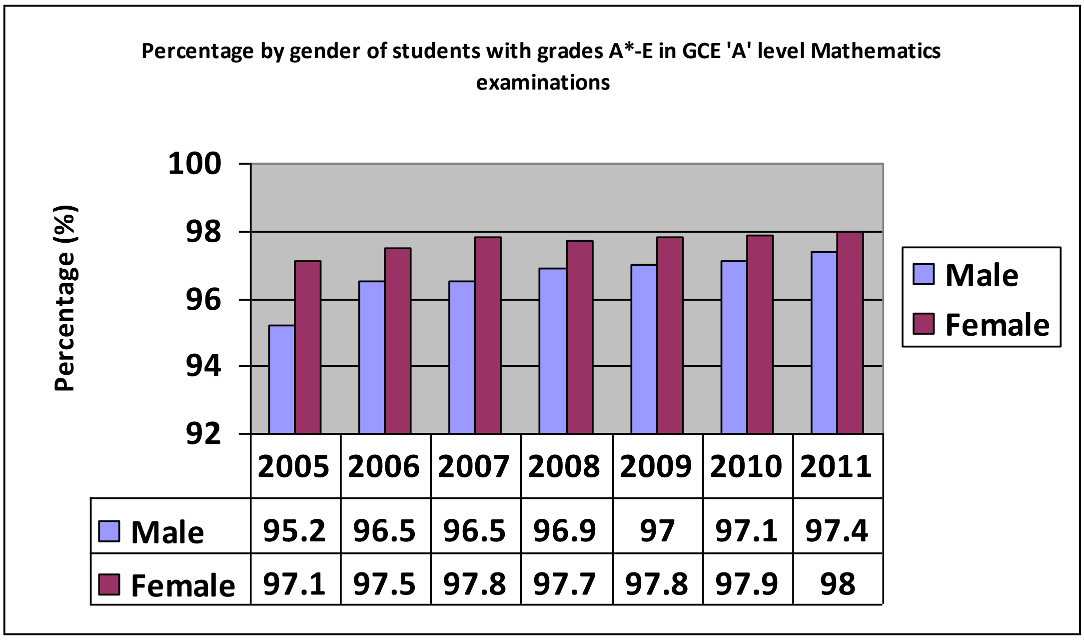
Table 9 demonstrates which gender group has seen the highest increase in participation in A-level Mathematics between 2005 and 2011. The changes recorded in Table 9 were determined using the data from the graph (Fig. 6). For example, between 2005 and 2006, the number of females who sat A-level Mathematics increased by 1711 (i.e. 21889-20178=1711). The percentage rise in participation of female is therefore calculated as (1711/20178)x100 = 8.5%.

It is evident from Figure 6 that more boys took A-level Mathematics than girls, but Table 9 shows that between 2005 and 2010 there was a percentage rise in female participation each year, which is smaller than that of males. It is only between 2010 to 2011 that a higher percentage of male students than female took the examination. Comparing 2005 with 2011, shows that girls' participation has gone up by 64.4%, whereas that of boys has gone up by 52.3%. This however does not make up for the differences in participation considering the fact that at GCSE level more girls than boys acquired the required grade for A-level Mathematics study. The next section examines whether higher male participation in A-level Mathematics is associated with higher level performance or not.

4.2.1(ii) Comparison in performance in A-level Mathematics by gender

Figure 7 below shows the percentage of students with grades A*-E in GCE A-level Mathematics by gender. This graph originates from Table 8. The calculation of the percentages is based on a similar approach used in Section 4.1.2 (ii) above.

Figure 7: Performance of students in GCE A-level Mathematics examinations



It is important to the aim of this study to know by gender the performance of students in A-level Mathematics. The significance of this is to establish whether the performance of students in past examination results might play a role in either motivating or discouraging other students from choosing A-level Mathematics.

Despite Figure 6 showing higher male participation in A-level Mathematics Figure 7 shows steady better performance of females than males between 2005 and 2011. 2005 saw the highest difference of 1.9% (i.e. 97.1-95.2=1.9) in examination performance between male and female, in 2006 the difference was 1.0%, in 2007 (1.3%), in 2008 (0.8%), in 2009(0.8%), in 2010 (0.8%) and in 2011 is 0.6%, all in favour of females. The next sub-section examines the participation and performance of students in A-level further Mathematics, which is an extension of the A-level Mathematics. The importance of analysisng the A-level Further Mathematics examination results to this study is to determine whether there are any trends in participation and performance either different or similar to A-level Mathematics. This because A-level Further Mathematics is a higher level of Mathematics study compared to A-level.

4.2.2(i) Comparison of students' participation in GCE A-level Further Mathematics examinations by gender

Figure 8 shows the number of students who took GCE A-level Further Mathematics from 2005 to 2011 by gender. Similarly to Figure 6, the data for this graph was derived from Table 8.

Figure 8: Students' participation in A-level Further Mathematics examinations

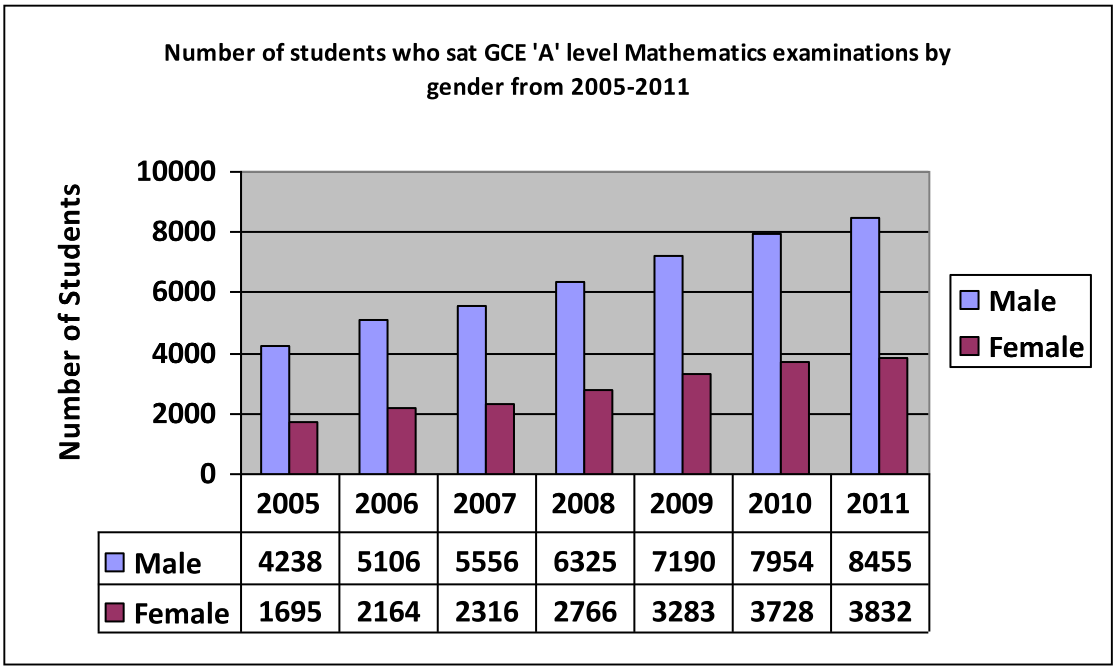


Figure 8 shows that between 2005 and 2011, more boys than girls took A-level Further Mathematics. The graph also shows increases in participation by both males and females. Similarly to the method used in Table 9, Table 10 also shows the percentage change in participation of A-level Further Mathematics from 2005 to 2011.

Table 10: Changes in participation in A-level Further Mathematics by gender from 2005 to 2011

	Percentage change in participation in GCE A-level further Mathematics by gender from 2005 to 2011					
	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Male	20.5	8.8	13.8	13.7	10.6	6.3
Female	27.7	7.0	19.4	18.7	13.6	2.9

Similarly to Table 9, the importance of Table 10 is to determine which gender group has seen the highest increase in participation in A-level Further Mathematics between 2005 and 2011. The percentage changes recorded in Table 10 were determined using the same method as in Table 9.

Figure 8 shows that in 2005, females represented 28.6% of the total number of students who sat A-level Further Mathematics examinations. In 2006, females were 29.8%, in 2007(29.4%), in 2008(30.4%), in 2009(31.3%), in 2010(31.9%) and in 2011(31.2%). In section 4.2.1(i) females formed between 38.1 to 40.6% of the total number of students who sat A-level Mathematics. There is however a decline in participation in A-level Further Mathematics. Females accounted for between 28.6 to 31.9% of the total number of students who sat A-level Further Mathematics for any particular year. Comparing this trend in A-level Further Mathematics with A-level Mathematics suggest that in all the years under consideration, female participation has declined as Mathematics advances. In 2005 for instance, females formed 38.1% of the total students who sat A-level Mathematics, but in A-level Further Mathematics they formed 28.6%. Similar declines are also observed in the various years. The next section 4.2.2(ii) examines the extent to which lower participation of females in A-level Further Mathematics is related to performance.

4.2.2(ii) Comparison in performance in A-level Further Mathematics examinations by gender

Figure 9 below shows the percentage of students with grades A*-E in GCE A-level Further Mathematics by gender. This graph was created from Table 8. Section 4.1.2(ii) shows examples of how the data used for the graph was generated.

Figure 9: Performance of students in A-level Further Mathematics examinations

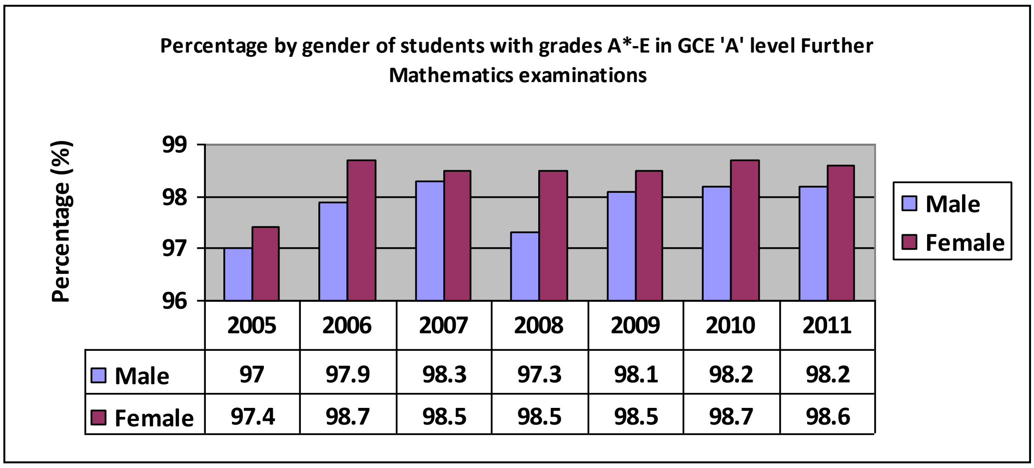


Figure 6 shows that for all the years under consideration in this study, the proportion of females obtaining A*-E was higher than males. With the exception of 2005, females' performances had been above 98% (grades A*-E). In 2005, the difference was 0.4%, in 2006(0.8%) and in 2007(0.2%). 2008 saw the highest difference of 1.2%. In 2009 the difference was 0.4%, 2010(0.5%) and in 2011(0.4%) all in favour of females. This shows that low participation of females in Mathematics as the level of Mathematics advances has no impact on their performance; this is evident from the fact that for all the various years in both A-level Mathematics and Further Mathematics, female performance was better than male.

4.3 Conclusion

The aim of this first analysis section was to respond to the first two research questions stated at the beginning of this chapter. The study has identified differences in the examination performance between boys and girls at both GCSE and A-level. There were also differences in the proportion of boys and girls undertaking A-level Mathematics. At GCSE level, the number of girls who qualified to pursue A-level Mathematics was higher than boys, but this high rate of performance is not reflected in the number of girls choosing to study A-level Mathematics. Over the same period (2005-2011) of the study, boys' participation in A-level Mathematics was higher than girls. The gap between the numbers of male and female students' participating in A-level Further Mathematics becomes wider still. Despite more boys taking A-level Mathematics, where girls do participate, their performance overall is better than that of the boys.

CHAPTER FIVE: Data Analysis 2

The second chapter of data analysis in this study focuses on the primary data collected through the self-completed questionnaires and the in-depth interviews. The main aim of this empirical study was to investigate the factors influencing the choice of Mathematics at A-level from a gender perspective. This second stage of data analysis addresses Research Questions 3, 4 and 5; i.e. "What factors influence the choice of Mathematics at A-level?", "What are Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level?", and "What are students' perspectives about gender and the choice of Mathematics at A-level?"

Three case study schools were involved in the study and the key informants were a sample of teachers and students in each of the schools. The two main methods used for collecting the data in this study were self-completed questionnaires and the in-depth interviews. (For the selection criteria of informants see Chapter 3). The approach for analysing the data from the schools is based on Thematic Coding Analysis (Silverman, 2011) which has been used to analyse the data from the in-depth interviews. The self-completed questionnaires consist of a mix of both qualitative and quantitative data. The qualitative aspect of the self-completed questionnaire data was analysed using Thematic Coding Analysis, whereas the quantitative data analysis was based on descriptive statistics, inferential statistics and statistics in perspective (For details see Chapter 3). The self-completed questionnaires were administered to both A-level and GCSE students, whereas the in-depth interviews were conducted with A-level students and their teachers. A total of seven teachers (five males and two females) and 16 students (eight males and eight females) were interviewed.

According to Silverman (2011) the main purpose of a theme is to capture important patterns in the data in relation to the research questions. In this analysis, therefore, the aim of the study and the research questions influenced identification of themes. There were, however, themes that emerged from the self-completed questionnaires and the semi-structured interviews that were anticipated in the study but were not popular among the students' reasons for choosing Mathematics. These have been captioned “anomaly themes” in this analysis. The data analysis was completed in sections. Section 5.1 focuses on the self-completed questionnaires and Section 5.2 on the in-depth interviews. This is then followed by Section 5.3, which presents the analysis of the self-completed questionnaires and the in-depth interview data together, in conjunction with the model of academic choice which is the framework for this study. The model and its significance to the study have been explained in Chapter 2 (Section 2.6).

5.1 Quantitative and qualitative analysis of the self-completed questionnaires

The main purpose of this section is to present, analyse, interpret and evaluate the self-completed questionnaires completed by students at both GCSE and A-level in three schools, quantitatively and qualitatively. As stated earlier, three different self-completed questionnaires were administered to the students in the three schools involved with the study. This part of the analysis focuses on the self-completed questionnaires administered to A-level Mathematics students, to A-level students who could have studied A-level Mathematics but chose not to and to the third group of GCSE top-set Mathematics students. Table 11 shows the distribution of the self-completed questionnaires in each school.

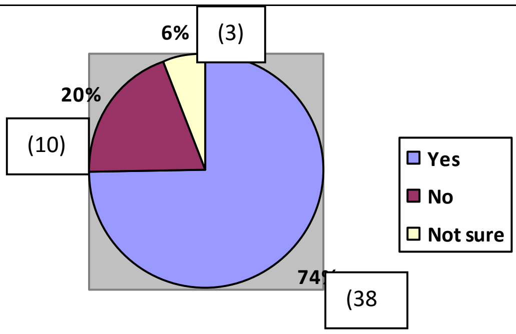
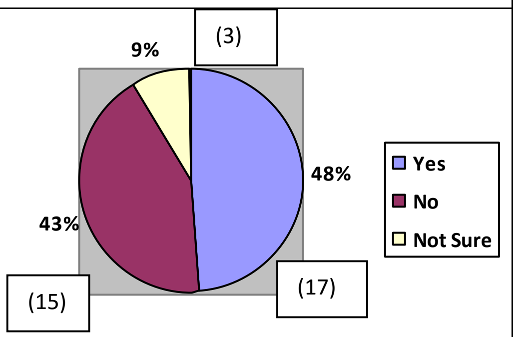
Table 11: Questionnaire Distributions

	A-level Mathematics Students		**A-level students not studying A-level Mathematics but could have done it**		**GCSE top-Set Mathematics students**	
	Male	Female	Male	Female	Male	Female
School A	31	17	6	11	13	21

School B	33	21	2	4	17	10
School C	32	23	1	13	21	4
Total	**96**	**61**	**9**	**28**	**51**	**35**
	157		**37**		**86**	
	280					

Out of the 51 male GCSE top-set students, 38 expressed an interest in studying A-level Mathematics, three were not sure and 10 were not interested in A-level Mathematics. In the case of the female students, 17 out of 35 were interested in studying A-level Mathematics, three were not sure and 15 were not interested A-level. Figure 10 below shows the pie chart for this data.

Figure 10: GCSE top-set in Mathematics students

Male (51)	Female (35)
	

The purpose of this section is to address the research questions stated above. Research Questions 3 and 5 have formed the basis for the following sub-sections of the analysis:

5.1.1 Factors influencing the choice of A-level Mathematics

5.1.2 Students' perspectives about gender and the choice of Mathematics at A-level

Sub-section 5.1.1 focuses on factors which either motivated or prevented students from choosing A-level Mathematics, whereas Sub-section 5.1.2 focuses on the students' perceptions about gender and the choice of Mathematics.

5.1.1 Factors influencing the choice of A-level Mathematics

The analysis identified three headings under factors influencing the choice of A-level Mathematics:

5.1.1(i) Factors motivating students to choose A-level Mathematics

5.1.1(ii) Factors preventing students from choosing A-level Mathematics

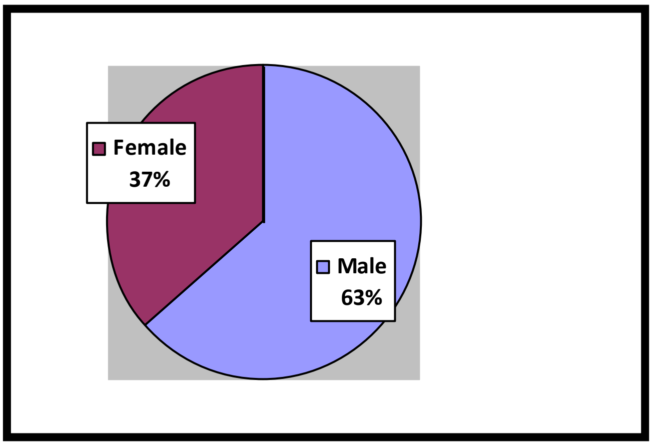
5.1.1 (iii) Background of parents in Mathematics.

The analysis of 5.1.1 (i) is based on the views expressed by the A-level Mathematics students and the top-set GCSE students who wanted to study A-level Mathematics. 5.1.1 (ii) is based on the views of A-level students who could have studied A-level Mathematics and the GCSE top-set students who are not interested in studying A-level Mathematics. 5.1.1(iii) examines the mathematics background of parents of students' participants.

5.1.1(i) Factors motivating students to choose A-level Mathematics

This part of the analysis is based on the 157 students (96 males and 61 females) studying A-level Mathematics and 55 GCSE top-set students (38 males and 17 females) interested in studying A-level Mathematics. The proportional representation of male and female students under this group is shown in the pie chart below (Figure 11).

Figure 11: GCSE students' interest in A-level Mathematics



The analysis has been done according to gender to reflect the objective of the study. Five main themes were identified from the written responses from both the male and female Mathematics students. These responses were in relation to the factors influencing the students' choice of A-level Mathematics. The responses have been categorized under the following themes:

i. Performance in GCSE Mathematics

ii. Link with other subjects of interest

iii. Enjoyment of Mathematics

iv. Importance of Mathematics to career

v. Prestige in Mathematics.

There were, however, some other themes which were not popular among the students' responses but were important to the objective of the study. These have been classified as anomaly themes and they include:

a) Teacher influence

b) Parental influence.

The frequency of occurrences from the students' responses also influenced the choice of the themes above. Details of how the individual themes showed up in the students' responses are as follows:

i. Performance in GCSE Mathematics

The theoretical framework of this study suggests that previous performance of a student in a subject can impact on future choice of subject for study (Eccles et al., 1985). This is what makes the performance of students at GCSE level an important aspect of this study. This notwithstanding, the performance in GCSE Mathematics as a theme was identified from both male and female students' responses to the question: *"Why did you choose to study A-level Mathematics?"* Some of the views expressed by the students included:

> *"I got quite a good grade at GCSE."*
>
> *"[Maths is] something I am good at."*
>
> *"Maths was and still is my favourite subject and I don't think I'm bad at it."*
>
> *"I enjoyed GCSE Maths and achieved a high grade."*

There were no distinct differences between the responses of male and female students. The views expressed by both male and female students show that irrespective of gender, past performance in Mathematics can influence a person's later decision to study Mathematics.

ii. Link with other subjects of interest

The views expressed by some students revealed that they see Mathematics as a subject that links well with other subjects of interest. This, in their view, influenced students' choice of A-level Mathematics. In response to the question *"Why did you choose to study A-level Mathematics?"* views stated by both male and female students included:

> *"I want to do Physics at university so I require Mathematics at A-level."*
>
> *"Fits with other subjects I study at A-level."*
>
> *"I thought it would help with Chemistry."*

“I was good at it in GCSE and it complements Physics which I want to do in the future.”

The link with other subjects in this case shows the importance of Mathematics in linking across the curriculum. The views of both male and female students suggest that this link of Mathematics with another subject of interest played a part in their decisions. Some of the responses also show that it was not the only factor. It is also evident that the link between Mathematics and other subjects of interest was not peculiar to any particular gender.

iii. Enjoyment of Mathematics

The analysis also found that students’ choice of Mathematics at A-level was a result of their previous enjoyment of Mathematics. Similar to the theoretical framework, once past enjoyment of a subject fits into the idea that past experiences of the student can influence the student’s attitudes and expectations. For instance, students stated:

“It was a subject that I enjoyed and excelled at and [I was] keen to expand my knowledge and improve my skills.”

“Love it.”

“I have [a] passion for Maths.”

“I enjoyed [it] and felt good at it.”

“It was fun at GCSE and I got an ‘A’.”

These responses from both male and female students are an indication that enjoyment of Mathematics can influence students’ decision to pursue study in Mathematics.

iv. Importance of Mathematics to career

Other students demonstrated that their decision to study A-level Mathematics was a result of the perceived importance of Mathematics to a career they have in mind. This finding is in agreement with the theoretical model which suggested that the decision of a person to opt for Mathematics can be influenced by the importance of Mathematics to future careers (Eccles et al., 1985). These views were not peculiar to any particular gender. For instance, some of the students stated:

> *"It was my strongest subject and [I decided to take it] because of [the] career opportunities."*
>
> *"[I am] interested in Maths and want to do Maths at university and be a Maths teacher."*
>
> *"Requirement for university course."*
>
> *"A good subject for further studies."*
>
> *"Good job opportunities."*

v. Prestige in Mathematics

Prestige as a factor influencing the choices by students is supported by the theoretical model which suggests that career choice is influenced by extrinsic factors such as salary expectations, cost and length of training (Dick and Ralies, 1991). The extrinsic factor in this case is prestige. In response to the question: *"Why did you choose to study A-level Mathematics?"* students stated:

> *"It is a respected and valuable A-level."*
>
> *"It is classified as a key A-level and seen as impressive."*
>
> *"It proves that you have a logical mind."*
>
> *"It's recognition and high status."*

These responses, from both genders, suggest that the perception that Mathematics is a prestigious subject does impact on students' choices.

5.1.1(i(a)) ANOMALY THEMES

The anomaly themes in this study refer to themes that were expected but were not cited by many participants. These are the influence of teachers and parents on the students' choice of Mathematics.

a) Teacher influence

The view expressed by Fennema (1990), that students' beliefs about themselves can be affected by the teachers' beliefs about them, was identified in the responses of some of the students. The responses from the self-completed questionnaires identified views from students whose choice of A-level was influenced by their teachers. In answer to the question, *"Why did you choose to study A-level Mathematics?"* students stated:

> *"The Maths teachers at my school [were] very good teachers and [it was] the best department."*
>
> *"My year 10/11 teacher."*
>
> *"My GCSE teacher, and [I] also found it enjoyable."*
>
> *"Praise from teachers which makes me feel I can achieve highly in it."*

b) Parental influence

Parental influence is a factor discussed in the literature review (See Chapter 2). Among the few responses from both male and female students which suggested parental influence as their reason for studying Mathematics were:

> *"[I] found it easy at GCSE, [was] encouraged by [my] grandparents and required [it] for [my] university course."*
>
> *"Parents."*
>
> *"Enjoyment and encouragement from parents."*

“Parental pressures and siblings in sixth form enjoying the subject.”

“Family pressures and it is a good A-level to have.”

Expectations of parents towards their children depend on the background of the parents (Joe and Davis, 2009). It is based on this concept that the background of parents, or carers, in Mathematics becomes important. In the questionnaires students were asked to state the highest level their parents had achieved in Mathematics. Table 12, below, shows the breakdown of the responses.

Table 12: Parents whose wards were interested in or studying A-level Mathematics

Mathematics level of parents of A-level Mathematics and GCSE top-set students					
	Below GCSE	GCSE but not beyond	A-level but not beyond	Beyond A-level	Not Sure
Male(134)	9(6.7%)	55(41.0%)	45(33.6%)	21(15.7%)	4(1.0%)
Female (78)	9(11.5%)	37(47.4%)	17(21.8%)	13(16.7%)	2(2.6%)

Table 12 shows that 50.3% (33.6%+15.7%+1.0%) of the parents of the male A-level Mathematics students and the GCSE top-set students’ level of Mathematics were beyond GCSE level. Whereas only 41.1% of the female students’ parents' level of Mathematics were beyond GCSE level.

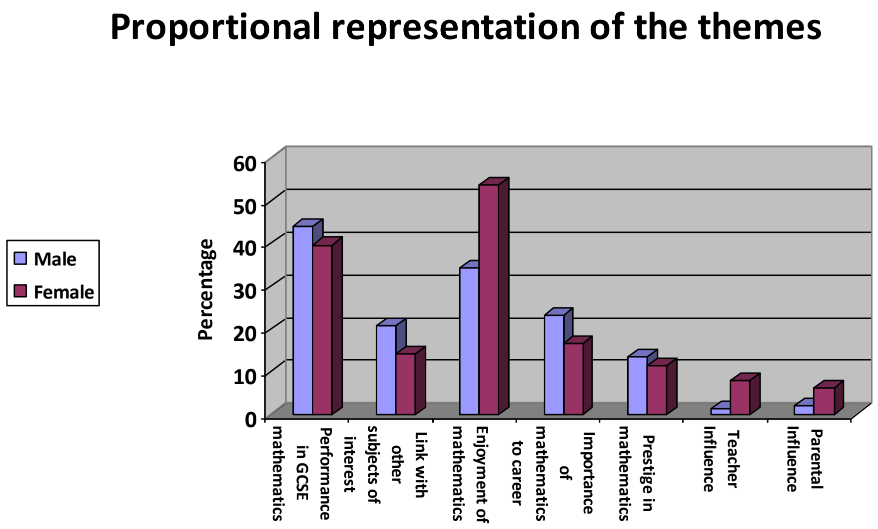
In summary, Table 13 shows the number of students whose views represented the various themes. In all cases students stated more than one factor which had influenced their choices of Mathematics.

Table 13: Proportional representation of the themes

Themes	**Male(134)**	**Female(78)**
Performance in GCSE Mathematics	59(44.0%)	31(39.7%)
Link with other subjects of interest	28(20.9%)	11(14.1%)
Enjoyment of Mathematics	46(34.3%)	42(53.8%)
Importance of Mathematics to career	31(23.1%)	13(16.7%)
Prestige in Mathematics	18(13.4%)	9(11.5%)
Teacher influence	2(1.5%)	6(7.9%)
Parental influence	3(2.2%)	5(6.4%)

Figure 12 below shows the proportional representation of the various themes as identified from the responses of the A-level Mathematics students and the GCSE top-set in Mathematics who are interested in studying A-level Mathematics.

Figure 12: Proportional representation of the themes



Out of the seven themes identified, more male than female students' decisions to study A-level Mathematics were influenced by:

i. Performance in GCSE Mathematics

ii. Link with other subjects of interest

iii. Importance of Mathematics to career

iv. Prestige in Mathematics.

On the other hand, more female than male students' decisions were influenced by:

i. Enjoyment of Mathematics

ii. Parental influence.

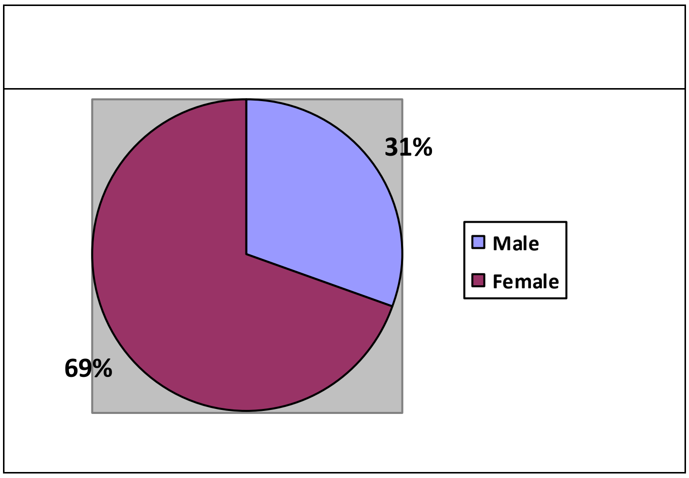
Figure 12 clearly shows that the decision by male students to study A-level Mathematics was influenced more by performance than by enjoyment, whereas female students were the opposite.

5.1.1(ii) Factors preventing students from studying A-level Mathematics

This sub-section focuses on the responses from the A-level students who had grades A*-B in GCSE Mathematics but chose not to study A-level Mathematics and the top-set GCSE Mathematics students who are not interested in studying A-level Mathematics.

In total 62 questionnaires were completed and returned under this category; this is based on 37 (nine males and 28 females) A-level students not studying A-level Mathematics and 25 (10 males and 15 females) top-set GCSE students not interested in studying A-level Mathematics. The proportional representation of male and female students in this category is shown in the pie chart below (Figure 13).

Figure 13: Factors influencing students not to choose to study A-level Mathematics



Four main themes were identified from the responses to the question on why they did not (or will not) choose A-level Mathematics:

i. Irrelevance of Mathematics to career
ii. Lack of interest/enjoyment in Mathematics
iii. Mathematics as a difficult subject
iv. Lack of confidence.

i. Irrelevance of Mathematics to career

One of the parameters of the theoretical Model of Academic Choice is the influence of immediate or long range goals on the choices students make. This is what makes the irrelevance of Mathematics to career an important theme. Some of the reasons stated by both male and female students reflecting this theme include:

> *"It would not help the type of work I want to go into."*
>
> *"It is not what I want to do in [the] future."*
>
> *"…. it wasn't essential for my career path … if I needed it I would have taken it."*
>
> *".... it does not fit into my future career."*

ii. Lack of interest/enjoyment in Mathematics

Intelligence, enjoyment or interests are considered in the theoretical model as the intrinsic factors contributing to students' choice of subjects. In this study lack of interest/enjoyment in Mathematics was cited by some of the students as being one of the reasons for not choosing A-level Mathematics. Male students stated that:

> *"I chose other subjects I enjoyed more."*
>
> *"I don't enjoy Maths."*

The female students cited the following:

> *"Maths doesn't interest me."*
>
> *"I dislike the subject and so I chose Physics as the alternate option for university application."*
>
> *"I didn't enjoy studying Maths. Maths was a subject which required more effort rather than talent and ability."*

It is worth noticing that a female student, due to her dislike for Mathematics, chose to study A-level Physics instead. Physics was, however, seen by some of the students as one of the subjects which is linked with A-level Mathematics. Teachers also agreed about the existence of this link between Mathematics and Physics.

iii. Mathematics as a difficult subject

Even though some of the students obtained the required grade to enable them to study A-level Mathematics they felt that GCSE Mathematics was difficult for them. They perceived that they had to struggle to achieve the good grade they had at GCSE. Others felt that A-level Mathematics was going to be even more difficult and that they would not be able to cope. Some of the views cited by the students include the following:

> *"I felt the gap was too big to start Maths again."*
>
> *"I found the subject hard and I had no interest in it."*
>
> *"Appeared to be too challenging for me from the start of the course onwards."*
>
> *"Although I got good grades, I struggled. I want to be an art teacher and I don't think Maths would help."*
>
> *"[It was] too difficult, [I] had other subjects to take, [and] Maths doesn't interest me."*
>
> *"I don't like Maths, I find mental arithmetic difficult."*

iv. Lack of confidence

Lack of confidence also played a part in some students' decisions in avoiding A-level Mathematics. In expressing these views students stated:

> *"I didn't feel confident enough in it."*
>
> *"I felt that I did not have the ability to achieve a good grade."*
>
> *"I didn't think I could get a good grade in the subject."*

"It is quite hard and I don't have a huge level of confidence in the subject."

"[I] didn't enjoy it, didn't think I would get a good grade in Maths at A-level."

5.1.1 (iii) Background of Parents in Mathematics

In the literature it was identified that parents' expectations for their children was often influenced by their own background (Joe and Davis, 2009). Table 14 shows the educational level in Mathematics of parents whose wards are either not studying A-level Mathematics or are in the top-set GCSE but not interested in A-level Mathematics.

Table 14: Parents whose wards are not interested in or not studying A-level Mathematics

Mathematics level of parents whose wards are not interested in, or not studying, A-level Mathematics					
	Below GCSE	GCSE but not beyond	A-level but not beyond	Beyond A-level	Not Sure
Male(19)	0(0%)	11(57.9%)	4(21.0%)	3(15.8%)	1(5.3%)
Female (43)	5(11.6%)	18(41.9%)	13(30.2%)	6(14.0%)	1(2.3%)

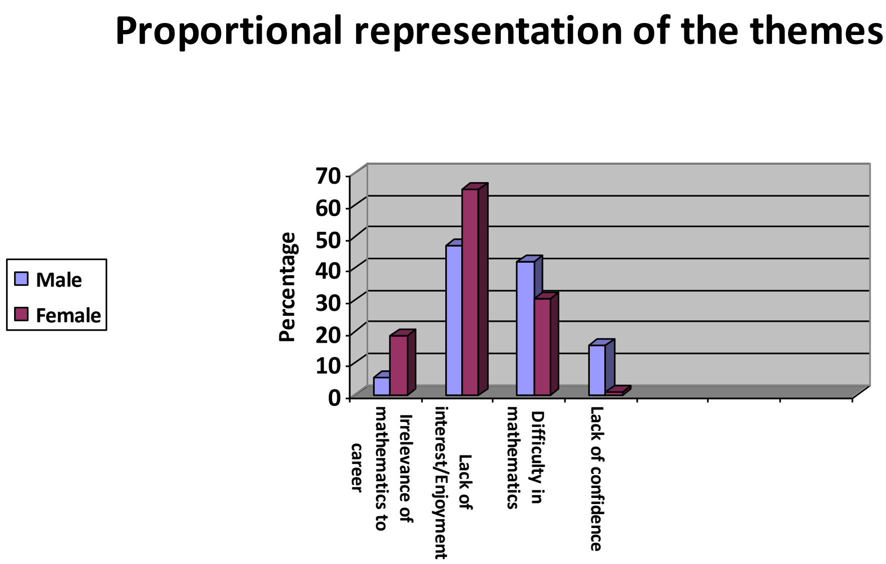
Table 14 shows that 57.9% of male students and 53.5% (11.6%+41.9%) of female students had parents that did not go beyond GCSE level in Mathematics. Comparing this with Table 12, it shows that the higher the parents' level of Mathematics the more likely they are able to influence their children to study Mathematics at a higher level.

Table 15 and Figure 14 show a summary of the participants' responses to the various themes.

Table 15: Summary of the participants' responses to the various themes

Themes	Male(19)	Female(43)
Irrelevance of Mathematics to career	1(5.3%)	8(18.6%)
Lack of interest/enjoyment	9(47.4%)	28(65.1%)
Difficulty in Mathematics	8(42.1%)	13(30.2%)
Lack of confidence	3(15.9%)	3(7.0%)

Figure 14: Proportional representation of the themes



From the graph (Figure 14), lack of interest or enjoyment is the major factor keeping both male and female students from studying A-level Mathematics. It is evident that finding factors that can increase student interest or enjoyment in Mathematics may subsequently increase student participation in A-level Mathematics. In comparison with Figure 12, this shows that a high proportion of the female students who chose A-level Mathematics did so because they enjoyed the subject. It can therefore be inferred that making Mathematics interesting and enjoyable can increase female students' participation in A-level Mathematics.

5.1.2 Students' perspectives about gender and the choice of Mathematics at A-level

This section examines the perceptions of students in relation to gender and the choice of Mathematics at A-level. The main themes and sub-themes identified from the students' perception of gender and the choice of Mathematics are as follows:

1) Factors contributing to gender differences in performance in Mathematics

    i. Teacher support

    ii. Attitudes towards learning Mathematics.

2) Factors contributing to gender differences in the choice of A-level Mathematics

    i. More subject options available for girls than boys

    ii. Lack of confidence

    iii. Gender differences in preference of subjects

    iv. Gender-dominated profession

    v. Gender differences in enjoyment of subjects

    vi. Threat of stereotype.

Theme 1, the factors contributing to gender differences in performance in Mathematics, and the ensuing sub-themes, were identified from the responses to the question *"What has contributed to girls performing well in GCSE Mathematics?"* Theme 2, factors contributing to gender differences in the choice of A-level Mathematics, and the ensuing sub-themes, were identified from the responses to the question *"Despite girls performing well in GCSE Mathematics why do fewer girls than boys choose to study A-level Mathematics?"* The analysis is based on 280 (156 males and 124 females) students' responses to the self-completed questionnaires.

1) Factors contributing to gender differences in performance in Mathematics

The views expressed by the students as what they perceived to be factors contributing to gender differences in performance were two-fold:

i. Teacher support

ii. Attitudes towards learning Mathematics.

i. Teacher support

Teacher support as a factor contributing to differences in performance by gender was pointed out by both male and female students.

For instance, the male students, in explaining why girls perform well, stated:

“[There is] more tutoring support for girls … males [are] too proud to ask for help.”

“Girls tend to get more support from teachers.”

“Men are better, women get more help.”

“Girls get more attention.”

“Male teachers like girl students who are good in Maths.”

Similar views were also shared by some of the female students who stated:

“Girls receive more support from teachers.”

“Girls ask for more help than boys.”

ii. Attitudes towards learning Mathematics

Different views were expressed by both male and female students in relation to attitudes towards learning Mathematics. In response to the question *“What has contributed to girls performing well in GCSE Mathematics?”* some of the male students held the view that:

> *“Girls have better concentration, [and are] more likely to revise and [are] more organised.”*
>
> *“I believe there are more mature girls than boys … mature pupils do more work and this gets them higher grades.”*
>
> *“Girls try harder but are not interested in Maths.”*

Some of the female students also explained:

> *“Girls may be naturally more clever [sic] and may also work harder.”*
>
> *“Girls can generally be more systematic and organised with work which I think is necessary to gain full understanding of Maths.”*
>
> *“…. girls know that they are rubbish therefore [they] work harder.”*

The views expressed show that both genders acknowledged that female students tend to work harder at GCSE level than their male counterpart.

2) Factors contributing to gender differences in the choice of A-level Mathematics

The views expressed by the students on this theme have been categorised into the six sub-themes stated above.

i. More subject options available for girls than boys

Some of the students believed that girls had more subject options than boys and therefore found other subjects more appealing to them than Mathematics. Some of the male students, in stressing this point, stated that:

> *“Other subjects … [are] more popular to them ... Girls prefer coursework-related subjects such as Modern Foreign Languages or English.”*

"…. girls tend to study scientific subjects as well as arts subjects, boys sometimes stick to one area."

The female students confirmed this:

"Girls have other options they [can] take up to get good jobs [e.g.] Health and Social is taken if they want to be a nurse."

"Girls have a desire to study more creative subjects [e.g.] Dance, Design & Technology."

ii. Lack of confidence

Lack of confidence has also been seen by some of the students as a factor influencing the choice of Mathematics. Lack of confidence was shown in different forms from the students' responses. This included the fear of not doing well in Mathematics if they went on to study it at A-level. The responses which supported the lack of confidence as a factor influencing the choice of Mathematics from the male students' perspective included:

"…. not knowing if you can obtain higher grades [in Mathematics] whereas it may be easier in other A-level [subjects] such as English."

"Girls are not confident to handle more loads"

Some of the female students were of the view that:

"More girls than boys do not have the confidence in their ability."

"Girls may not feel encouraged to study Maths."

"The step up in difficulty is challenging for girls."

iii. Gender differences in preference of subjects

The views of the students also suggest that they themselves have identified gender differences in preferences of subjects. Responding to the question *"Despite girls performing well in GCSE Mathematics why do less girls than boys choose to study A-level Mathematics?"* some of the male students were of the view:

> *"Girls go for other subjects … more boys like Maths."*

> *"Because it is a technical subject, girls really don't like a subject like that."*

> *"More boys choose [to] do A-level Mathematics if they are uncertain about their future career … only girls that are strong mathematicians choose to do Maths at A-level."*

The female students also stated:

> *"Because … [girls] don't need the subject for courses of jobs they need to pursue."*

> *"Girls are good at other subjects too so they take those instead."*

> *"Girls are more interested in careers not involving Maths."*

The views of the informants in this group suggest that girls' performances are also better in other subjects as well as Mathematics. This gives female students a greater choice of subjects and they are therefore not restricted to Mathematics.

iv. Gender-dominated profession

Some students held the view that Mathematics has a link with male-dominated professions. Some male students, in explaining why female participation in A-level Mathematics is less than male, stated:

> *"Different interest, Maths is useful in Engineering, Physics etc. which may appeal to boys more."*

> *"Job opportunities with Maths are more favourable for boys than girls."*

Some of the female students agreed:

“I think boys may choose to study Mathematics as it complements their other subjects ... girls would prefer to do other subjects.”

“The subjects which are normally associated with Maths are Physics and Chemistry which are male-dominated subjects.”

“Maths is often needed more for male orientated courses at university.”

The views expressed by both male and female students on this sub-theme are indications that Mathematics as a subject is seen as more relevant in male-dominated careers.

v. Gender differences in enjoyment of subjects

Some students believed that gender difference did exist in the way in which students enjoy subjects. These differences in enjoyment can contribute to the choices students make. Some of the views from the perspective of the male students on this assertion were:

“Boys tend to enjoy Maths more than girls.”

“Many girls do not enjoy GCSE Maths due to poor teaching.”

The views from the perspective of some of the female students included:

“Girls tend to have other subjects that they enjoy more and don’t want to do something they don’t enjoy.”

“...girls outperform boys at GCSE through hard work not necessarily greater enjoyment.”

“In our generation there is an increasing emphasis on choosing subjects you enjoy over those you are necessarily best at … girls tend to be better at literary problems [and] this could reduce their enjoyment in Maths.”

The view expressed by one of the female students that there is great encouragement today to choose subjects that are enjoyable as well as necessary, is a point worth noting. This view suggests that despite the fact a student may be good at Mathematics, if they do not enjoy studying the subject, then they are less likely to take it further. This implies that promoting the relevance of Mathematics to try and encourage more participation will have little effect on increasing A-level participation if students are encouraged to consider enjoyment before necessity.

vi. Threat of stereotype

Stereotype is associated with public held beliefs about specific social groups or categories of individuals (Gelman et al., 2004). Steele (1992) described the threat of stereotype as the concern about being judged in comparison to a negative stereotype. Some of the views shared by male students which show the threat of stereotype included:

> *"… Stereotype of boys doing Maths and Physics A-level and girls don't want to break the stereotype."*
>
> *"Boys are more logical whereas girls are more dramatic."*
>
> *"Most girls tend to choose subjects which involve essay writing."*
>
> *"…. Maths is traditionally a male subject, girls are put off by their perception."*

Female students' had a similar understanding:

> *"Boys mostly study Science and Engineering which are linked to Maths."*
>
> *"It is considered to be more of a boy's subject due to traditional views."*
>
> *"Boys stereotypically will do Engineering requiring Maths."*
>
> *"Boys might be discouraged from doing 'girls' subjects such as Dance and Textiles so instead choose subjects like Maths."*

In the view of one of the female students, the greater number of boys than girls doing A-level Mathematics can be attributed to boys not being encouraged to study some of the courses that are perceived to be female subjects. This student suggests that the threat of stereotype is not only associated with Mathematics being perceived as a male-dominated subject, moreover that male students are not ready to explore other subjects perceived to be female-dominated.

In summary, students perceive teachers' support and gender differences in attitudes towards learning Mathematics as factors contributing to gender differences in performance in Mathematics. On the issue of gender differences in participation in A-level Mathematics, the perception amongst students was that girls had more subject options than boys. Students were also of the view that Mathematics-related professions tended to be more male-dominated.

5.2 Analysis of in-depth interviews

The two groups of participants involved in the in-depth interviews were teachers and A-level students from the three schools. On average, each teacher interview lasted between 25 and 35 minutes, with student interviews being slightly shorter at 20-30 minutes. Table 16 shows the details of the teachers involved from the three schools and Table 17 the details of the students. The names used to represent both teachers and student participants in this study are pseudonyms.

Table 16: Background of teacher informants in in-depth interviews

Schools	Teachers' names	Level taught	Teaching experience
A	Roger (Male)	Key stages 3 & 4 and A level	More than 10 years
	Lisa (Female)	Key stages 3 & 4 and A level	More than 15 years
B	Charles (Male)	Key stages 3 & 4, GCE O level and A-level	More than 26 years
	Maxwell (Male)	Key stages 3 & 4 and A level	More than 17 years

	Mathew (Male)	Key stages 3 & 4, O level and A level	More than 35 years
C	Jonathan (Male)	Key stages 3 & 4 and A level	More than 4 years
	Diane (Female)	Key stages 3 & 4 and A level	More than 13 years

Table 17: A-level student informants in in-depth interviews

	A-level Mathematics students		A-level non-Mathematics students	
	Male	**Female**	**Male**	**Female**
School A	Adams	Sandra	Joseph	Afua
	David	Betty	Ammish	Beatrice
School C	Isaac	Abena	Kwame	Juliana
	Tom	Asabea	Paul	Oparebea

Since the two main groups of informants involved with the in-depth interviews were teachers and students, the analysis sought to identify themes based on the views of the two groups. The views expressed were either grouped under factors influencing the choice of Mathematics at A-level (i.e. Research Question 3) or teacher/student perceptions of gender and the choice of Mathematics at A-level (Research Questions 4 and 5). Sub-section 5.2.1 focuses on teachers' views on the factors influencing students' choice of A-level Mathematics, followed, in sub-section 5.2.2, by an examination of students' views on the factors influencing the choice of A-level Mathematics. Sub-section 5.2.3

analyses teachers' perceptions about gender and the choice of Mathematics at A-level and sub-section 5.2.4 then evaluates student perceptions about gender and the choice of Mathematics at A-level.

5.2.1 Teachers' views on factors influencing the choice or otherwise of Mathematics at A-level

In all three schools, six major themes were identified from the teachers' views on the factors influencing the choice of Mathematics at A-level:

a) Students' enjoyment and performance in Mathematics

b) The relevance of Mathematics to students' career choice

c) Mathematics as a link with other subjects

d) The difficulty level of A-level Mathematics

e) Teacher influence

f) Parental influence.

Whereas some of the themes were unanimous views among all the seven teachers who took part in the interviews, others were not. Table 18 shows the summary of the themes, sub-themes and the corresponding number of teachers whose views have formed the basis of the themes identified.

Table 18: Summary of themes, sub-themes and the corresponding number of teachers

Themes	Male Teachers(5)	Female Teachers(2)	Total(7)
a) Enjoyment and performance in Mathematics	5	2	7
b) The relevance of Mathematics to career	5	2	7

choice			
c) Mathematics as a link with other subjects	4	1	5
d) The difficulty level of A-level Mathematics	5	2	7
e) Teacher influence	5	2	7
f) Parental influence	2	0	2
	5	2	7
	5	2	7

The following are some of the views expressed by the teachers about the above themes.

a) Enjoyment and performance

In response to the question *"What factors do the students consider before choosing A-level Mathematics?"* Jonathan stated:

> *"A lot of my GCSE students have basically been driven by their grades, they get an A or an A* … think they can cope with it and they think they are good at Maths."*

Responding to the same question, Maxwell emphasised the point on enjoyment and performance by stating that:

> *"…. I still think a lot of students take it because they enjoy Maths and they've enjoyed it up to GCSE. Some have found it relatively easy; the natural extension of that is to do A-level Maths …."*

Lisa stated that:

> *"…. I think [for] most of them it's enjoyment and success and obviously if they have got a career path."*

b) The relevance of Mathematics to career choice

The response of Roger to a similar question as that asked in point a) above, revealed that despite career choice being important enjoyment was still an over-arching factor:

> *"….actually there are some kids that do it because of the career or the university course they want but predominantly students choose it because they have enjoyed it lower down and it goes with other subjects they are choosing to do …."*

In the view of teacher Diane, a lot of boys' career choices are Mathematics related whereas girls' career choices are not often so. In stressing this point Diane stated:

> *"…. and it is about career aspiration as well because a lot of boys choose to do Maths because they know what they want to do long term and it involves Maths. A lot of girls know what they want to do long term and does not involve Maths."*

Teacher Lisa believed that for the majority of students, both enjoyment and career were important in subject choice:

> *"…. some of them pick it if they have got a career in mind but [for the] majority it turns [out] to be success and enjoyment of the subject which encourages them to carry on …."*

The views of the teachers expressed under (a) and (b) suggest that the relevance of Mathematics to future career is indeed a factor but is less important than high levels of enjoyment and performance.

c) Mathematics as a link to other subjects

Five out of the seven teachers were of the view that the importance of Mathematics to other subjects was also a factor that influenced the choice of

Mathematics at A-level. Some of the teachers expressed the following views when they were asked *"What factors do you think the students take into consideration before deciding to do A-level Maths?"*

> *Mathew: "…. I think it is beginning to change; a lot of students understand that Maths is an important subject to have. They see Maths as serving another subject, a career choice or subject they want to study at university. So if they are following sciences or Engineering they think Maths is important, if they are following arts they may choose it because they like the subject …."*

> *Roger: "So most students that do Physics are also doing Maths. We get a lot of students that are doing systems and control and computer science, that type of A-level."*

Mathew, in explaining why girls do not choose Mathematics, stated that:

> *"…. The girls tend to go for Social Sciences or Biology and they do not relate to Maths …."*

The views expressed by teachers suggest that, irrespective of gender, the choice of A-level Mathematics depends on how Mathematics fits with the other subjects the student is studying, or if it will aid their intended career.

d) The difficulty level of A-level Mathematics

Teachers perceive a big gap between the Mathematics curriculum at GCSE and at A-level. These teachers, in response to the question on what they have observed as constituting the differences between GCSE and A-level Mathematics, stated that:

> *Charles: "The big difference you will find is if you are averagely brilliant students, they get through GCSE with little effort but they soon find out that when they come to A-level they have got to work a bit harder. It's a big jump- mathematically we say discontinuity- it's a big jump between GCSE and A-level."*

Roger: "The algebra skills needed to achieve even an 'A' grade at GCSE are not really sufficient for what is needed at A-level. Our GCSE grades have gone up in the time I have been here both as a school and as a department. Although we get a lot of students coming through with 'As' and 'Bs' at GCSE they then go on to do A-level Maths, they haven't always got the algebra skills to be able to cope."

Lisa: "The A-level is probably at a much faster pace. Onus is on the students to do a lot more independent study of work although as a school we are trying to move that level down; it's very different at A-level. All the students that start the A-level find it hard to manage that kind of work."

Diane: "There is a big jump from GCSE to A-level … We offer a summer school for two or three days during the summer holidays for those students who have done GCSE and got a B to help them deal with the transition to A-level because it is a huge jump."

e) Teacher influence

The views expressed by the teachers in all the three schools also suggested that teachers' influence in the choice of Mathematics at A-level played a role in course selections. For instance, in response to the question *"Do the teachers have influence on students' choice of Mathematics?"* teacher Roger explained that:

"We have influence as teachers, we want to encourage students ... We do have an influence about it but I think really Maths is one of those subjects kids have made up their mind exactly what they want to do ... Often GCSE level and onwards they might want to think about A-level Maths and we make reference to it in our teaching. We have an open evening when they come [and] we do talk to them about it …."

In a similar view teacher Jonathan stated:

"…. We talk to them a lot during their careers interviews. So that has a factor on it as well. I suppose they are about combinations in subjects as well. People taking Physics are advised to take Maths as well …."

Lisa confirmed that:

"…. Obviously you could influence their enjoyment of the subject if you try to encourage them to do it, but to discourage, probably we don't do it. We have an open evening around early November and if they turn up we try to explain for them to know how hard it is and explain the situation. But usually we try to encourage them rather than discourage them."

In all the schools, despite students attaining the minimum requirement, teachers say they would not necessary encourage them to pursue A-level Mathematics, particularly if they perceived that the student in question would not be able to cope. When teachers were asked what they take into consideration before allowing students to do A-level Mathematics, some of the answers given were:

Diane: "….The main thing is their GCSE grade, we have an entry requirement - we favour a high B grade. Any student that got a B grade we will talk to very carefully and explain it to them that it is very difficult …."

Jonathan ".... I have openly said to them you're going to find it really hard, I mean you can go for it but you're going to find it really hard and you will have to make sure you have a lot of help."

Lisa: "….somebody just managed to get a B in the GCSE, Maths could be the best subject but to us we are thinking they will never cope with the level we are throwing at them."

Mathew: ".... Ok we have very little input in what subjects students take, obviously we can advise whether we think students are capable of studying Maths at A level ...."

f) Parental Influence

The study has identified from the teachers' point of view that parental influence can take one of two forms. Parents either provide a direct influence in the choice of subjects, or an indirect influence which is apparent in the offer of encouragement and/or assistance.

f (i) Subject selection

When Maxwell was asked if he was aware of parental influence as a factor determining whether students decided to do A-level Mathematics he answered:

> *"…. we've seen our numbers grow considerably in recent years. I think a lot of that particularly in this catchment is to do with parents noticing that universities are looking for particular A-levels and an A-level in Maths is highly sought after [for many] courses in universities."*

Maxwell further emphasised that:

> *"…. I think there are students that won't necessarily choose it but their parents have noticed what's going on in them, in the outside world and what's going on in the university entrances."*

Charles, when giving examples of the things students take into consideration before choosing A-level Mathematics, said:

> *"…. there is a parental influence as well depending on whether your parents are educated or not, some parents already map the future of their offspring for GCSE so they try to push them in a particular direction, sometimes it may not be in the best interest of the child … a parent may be good at Maths [but] that does not necessarily mean he/she should follow your footsteps."*

f (ii) Offering extra support in learning Mathematics

Teachers believed that interest and performance in Mathematics were enhanced if students received extra support from their parents. In response to a question asking whether teachers were able to detect students who received extra support at home in their Mathematics work, the following views were expressed:

> *Lisa: "Yes ... I have got a couple of my year 9 GCSE boys who are clearly getting help at home in their homework. They are more motivated in class now as well because they get that support at home."*

Lisa further stated:

> *"At A-level we had a student who this year was doing really badly struggling and since the parents evening obviously some intervention is coming in from somewhere at home and he is more able to get on with the work and more focused in general but particularly on the work, it's better."*

Jonathan corroborated Lisa's views:

> *"You can tell the difference. Some kids obviously don't [receive support] but what generally happens when you get help from home, the homework is generally more interesting either wanting to take things further if they are being helped by somebody at home."*

Contrary to the positive impact of parental support shared by teachers Lisa and Jonathan, Charles explained that:

> *".... The other noticeable thing is some of the students who get extra support from home do not sometimes pay attention ... sometimes it works in the negative. They do not to want to pay attention when you are laying the foundation."*

Two teachers in School B believed that there was little parental support in the form of assistance at home with GCSE level Mathematics, and that this diminished even further at A-level. In response to the question concerning the ability to identify students who received support at home in their studies of Mathematics, Mathew stated:

"To be honest I don't think there are many parents that will sit down and tackle A-level Maths with their kid. Some students do have a tutor but very few."

Maxwell said assistance at home was also dependent on socio-economic background:

"At this school there is a disparity between the amounts of support and help the students get particularly at GCSE depending on their social economic background … students from the wealthier backgrounds get more support outside school and this continues towards A-level."

However, in the view of Maxwell, receiving less help at home is not always a bad thing. Students at GCSE level who did well with little support from home often went on to do well in A-level without much support. In emphasising this point Maxwell stated:

"…. most of the students that do A-level tend to be from the more affluent areas but what we do find is those who are particularly good at Maths don't get as much support at home and continue to do well at A-level because they have had to deal with a lot of things by themselves up to that point so they are already prepared for the independent learning you need at A level."

g) Anomalies in teachers' views about factors influencing the choice of Mathematics

There were unusual responses from some of the teachers which addressed some of the research questions but were not recurring themes. Among them were the issues of:

1. Peer group
2. Confidence
3. Male teachers' dominance in teaching Mathematics at A-level.

1. Peer group

Two teachers interviewed were of the opinion that a student's peer group could influence the study of Mathematics either positively or negatively, but essentially did not influence the choice of Mathematics for further studies.

Teacher Roger stated:

> *".... Where there is a good positive relationship of equal partnership where both students in the pair working together if they both bring something to the partnership then I think it is really positive. Because they balance ideas of one another, they actually are talking about Mathematics. But when you've got two people where one of them is much better than the other then it is not as balanced …."*

Teacher Mathew had also witnessed the pressure of peer groups:

> *"…. at GCSE it depends on the social grouping … you can have a very able lad who mixes with a group of "street wise boys" and the friends don't want to be seen to be doing well and that can be a negative impact ... At A-level the friends tend to help each other, occasionally you get students who haven't got the maturity …."*

Out of the combined sample of teachers from all three schools, only one was of the view that the peer group could influence the choice of Mathematics at A-level. Charles said:

> *"…. peer pressure: 'my friends are going to do Maths and I want to do Maths as well' … because some of them will want to be in the same class because of the friendship they have made outside GCSE …."*

2. Confidence

On the issue of confidence, teacher Jonathan stated that:

"…. some of the kids who get grade B in GCSE Maths think that is not good enough. The top set most of them A and A and couple of Bs but set 2 pupils for example they get a bit under-motivated say "all the kids are getting A's and A* I feel a bit like I am not good enough with a B'', and I think that can be an influence on them if they want to take it or not."*

3. Male teachers' dominance in the teaching of A-level Mathematics

In response to the question *"What can be done to encourage more female participants in A-level Mathematics?"* two female teachers identified the dominance of male teachers in A-level as a disincentive to female participation in A-level Mathematics. Diane believed participation by female students could be encouraged *"…. by providing female role models.…"* However, she cautioned:

".... I worry that there are more boys doing it than girls but I wonder whether it's because we are actually appealing very much to the boys rather than we are not appealing to the girls' senses. If we have got both of them there that's ok. We don't want to squash the number of boys doing Maths just to even things up …."

Lisa also stated:

"If it is about role models then it is only me at the A-level."

The views expressed by the teachers above strongly indicate that teachers are influential in terms of student subject selection. According to the teachers, students who hitherto had enjoyed and performed well in GCSE Mathematics soon realised the big gap between GCSE and A-level and were either discouraged from further study or dropped A-level Mathematics.

5.2.2 Students' views on the factors influencing the choice of A-level Mathematics

This section examines the responses from two groups of A-level students. The first section (5.1.2 (i)) focuses on students studying A-level Mathematics, whereas the second section (5.1.2 (ii)) concentrates on students who could have studied A-level Mathematics but chose not to. In each group the individual views expressed have been analysed according to gender. This is firstly, to reflect the objective of the research study and secondly, as there were differences in the reasons cited by male and female students for their choice of A-level Mathematics.

5.2.2(i) Students' views on factors influencing the choice of A-level Mathematics given by students currently studying A-level Mathematics

In all, a total of eight A-level Mathematics students (four male and four female) were interviewed. Four major themes were identified under the factors influencing the choice of Mathematics at A-level:

a) The relevance of Mathematics to career choice

b) Enjoyment and performance in Mathematics

c) Teacher influence

d) Parental influence.

Table 19 shows the summary of the themes and the corresponding number of A-level Mathematics students whose views have formed the basis for the themes.

Table 19: Summary of themes and the corresponding number of A-level Mathematics students

Themes	Sub-theme	Male Students(4)	Female Students(4)	Total(8)

a) The relevance of Mathematics to career choice		3	1	4
b) Enjoyment and performance in Mathematics		2	4	5
c) Teacher influence		4	4	8
d) Parental influence	Parents offering help	2	2	4
	Parents offering encouragement	4	3	7

1. Male students' reasons for choosing A-level Mathematics

a) The relevance of Mathematics to career choice

Three out of the four male students who took part in the interview cited the relevance of Mathematics to their future career as a factor influencing their choice of A-level Mathematics.

David, in response to the question of why he chose to study A-level Mathematics, explained:

> *"I want to go to the university to do computer science and so I looked at the requirements and all of them require Maths. Quite a lot of them wanted Further Maths as well."*

When other students were asked what they had taken into consideration before they chose A-level Mathematics, they stated:

> *Isaac: "Future jobs basically ... because I was planning to be a pilot and I obviously need Maths…"*
>
> *Tom: "The reason why I took Maths was basically what I want to do afterwards ...."*

b) Enjoyment and performance in Mathematics

Two out of the four male students admitted that their enjoyment and good performance in GCSE Mathematics played a role in their decision to study the subject at A-level.

> David: "*Through GCSE the subjects I enjoyed most were Maths and Physics. Just because I got good grades and enjoy them at GCSE I thought of doing them at A-level."*
>
> *Isaac: "I enjoyed the GCSE Maths; it is good because you've got one set of required answer."*

c) Teacher Influence

The students' views suggested that the influence teachers had on their selection of Mathematics was mainly in a positive form. The influence of the teacher was intrinsically related to the enjoyment and performance students experienced in Mathematics.

In response to the question "*can you tell me about the people who have had impact on your learning of Mathematics?:*

> *David: "In Maths, at GCSE my teachers encouraged me; they kind of give some challenging questions.…"*

Isaac: "Obviously the school has got a successful Maths department … the teachers I have had have sort of pushed me into doing it … they are more friendly [sic], easy to talk to about work and other things."

Tom: "It's the teachers, they are passionate about Maths ... if you look across the school we do best in Maths ... If I struggle with my Maths work I just walk to the Maths department and they will help me …."

d) Parental Influence

With the exception of one student whose father had a direct influence on the choice of Mathematics at A-level, the others had support in different forms.

Question: What is the impact of your family on your choice of Mathematics?

Isaac: "My Mom is a head teacher and she's strong in Maths as well and knows the value of it …. It wasn't that she forced me to do what I do.... would have taken it anyway."

Tom: "My parents only encourage me to do what I am good at and what I enjoy doing."

David: "With my dad being a physics teacher he encouraged me to do Maths and science …. Even without my dad influencing me, I think I would have gone for Maths."

In general, all the male students had more than one reason for choosing A-level Mathematics. There were students who in addition to career choice cited factors such as enjoyment and performance as contributing to their decisions. For instance Adams, in response to the question *"what did you take into consideration before choosing to study A-level Mathematics?"* stated:

"Because of too much workload, I wasn't interested in any of the other subjects. I looked at career prospects as well. I picked Maths because I

am good at it. Art and sports because I enjoy them. It makes sense to pick them three … It was more because I was successful at GCSE Maths and I kind of had a grasp of it pretty quickly. I was pretty confident in it but now I am starting to regret it."

Adams' reasons for choosing A-level subjects in general can be categorised under the enjoyment, performance and the relevance of the subjects to career. Whereas his choice of Art and Sports were influenced by the enjoyment of the subjects, the choice of Mathematics was because of good performance at GCSE level. In response to a follow up question on why he was regretting his choice, Adams responded:

> *"It is at a faster pace than GCSE. So it's harder to pick up. I thought at GCSE the level of Maths is pretty much common sense. A-level is more in depth and I think I am quite a practical person. In GCSE it is easier to apply the methods in the knowledge of Maths to a practical purpose. Me personally, I need to understand why we use it and how it can be applied to something."*

David, on the other hand, stated:

> *"I want to go to university to do computer science and so I looked at the requirements and all of them require Maths. Quite a lot of them wanted Further Maths as well. Through GCSE the subjects I enjoyed most were Maths and Physics. Just because I got good grades and enjoy them at GCSE I thought of doing them at A-level. With my dad being a Physics teacher he encouraged me to do Maths and Science."*

In this case David was influenced by enjoyment, performance and career. His father also played a role in the choice of subjects, including Mathematics, at A-level.

2. Female students' reasons for choosing A-level Mathematics

a) The relevance of Mathematics to career choice

Only one out of the four female A-level Mathematics students cited the relevance of Mathematics to a future career as a reason for studying Mathematics at A-level, and this was not the sole reason. In response to the question *"what did you take into consideration before choosing to do A-level Mathematics?",* Sandra stated:

> *"That it will be good on your CV for job prospects and I enjoyed it."*

b) Enjoyment and Performance in Mathematics

All four female students mentioned enjoyment and performance as factors influencing their choice of A-level Mathematics.

> *Betty: "Maths, I was going to do it no matter what. I really love Maths; there was no doubt I was definitely going to do Maths. ... I like the challenge of it and I enjoy it."*

Abena, a female student taking Biology, Chemistry, Geography and Mathematics, stated:

> *"I want to do medicine at university so I needed the two sciences [Biology and Chemistry]."*

When Abena was asked if she could do medicine at university without Geography and Mathematics, she explained her choice of those subjects like this *"I really enjoy geography and I always like and enjoy Maths."*

When another student, Asabea, was asked the question "*whether her choice of A-level Mathematics was influenced by a career she has in mind?",* she answered:

> *"I don't have any career in mind apart from wanting to do Maths at university ... I have always liked it as a subject. I have found it fun and I want to do more of it."*

c) Teacher influence

Similar to the views of the male students, the female students attributed their choice of A-level Mathematics to their teachers' influence. Their responses suggested that teachers may have had an effect on their interest in and enjoyment of Mathematics at different stages of their academic career.

Abena attributed her strong interest in Mathematics to her teacher in her nursery school:

> *"…. I had a teacher when I was in nursery, when I was three … she used to give me little Maths problems … she kind of started so once I got to school I knew how to add."*

Asabea, on the other hand, developed an interest in Mathematics during years 9 and 10 primarily due to a particular teacher. When she was asked "*is there any period in your life that you felt encouraged or discouraged to do Mathematics?",* she replied:

> *"I was never even bothered about it until year 9 and year 10 … then from year 9 to GCSE I got this funny teacher ... he was the best teacher I ever had who saw me through it."*

d) Parental influence

Three out of the four female students had at least one of their parents interested in Mathematics. In response to the question *"[d]o you have some people in mind who have had an influence on your choice and interest in Mathematics?"*, Sandra responded:

> *"My parents ... My dad really likes Maths, but my mum not so much, he does engineering and he encourages me to do it."*

Betty also said:

"My dad quite enjoys Mathematics but they both help and encourage me."

Abena, however, admitted her strong interest in Mathematics was not linked to her parents. When asked *"[d]o you have any particular person who has influenced you in liking Mathematics?",* she responded:

> *"I don't know … both of my parents are terrible in Maths."*

The views expressed above by both genders, concerning the factors influencing the choice to study A-level Mathematics by current A-level Mathematics students supports the GMAC. These factors include previous performance and enjoyment in Mathematics. The evidence collected from this study confirmed that in both male and female students the idea that past performance had an influence on their present interest in Mathematics was comparable to the model of academic choice.

5.2.2(ii) Students' views on factors influencing the choice of A-level Mathematics from respondents who could have studied A-level Mathematics but chose not to

This section considers the viewpoints of A-level students who could have studied A-level Mathematics, as they gained grades A*-B in GCSE Mathematics, but chose not to. A total of eight students (four male and four female) took part in the interview process. In general, three main themes were identified:

a) The irrelevance of Mathematics to their career choice

b) Lack of enjoyment for Mathematics

c) Level of difficulty of Mathematics.

Table 20 shows the themes and a summary of the number of students' responses that corresponded to the theme identified.

Table 20: Themes and the number of students' responses corresponding to them

Themes	Sub-theme	Male Students(4)	Female Students(4)	Total(8)
a) The irrelevance of Mathematics to career choice		1	2	3
b) Lack of Enjoyment for Mathematics		4	2	6
c) Difficulty level of Mathematics		2	2	4

1. Male students' reasons for not choosing A-level Mathematics

Table 20 shows that, in addition to other factors, all four male students cited the lack of enjoyment for Mathematics as their reason for not choosing A-level Mathematics. The analysis found that one out of the four male students cited the lack of enjoyment combined with the irrelevance of Mathematics to their future career as the main reason for not choosing A-level Mathematics. Two of them cited lack of enjoyment and difficulty of Mathematics. Only one male student cited difficulty in Mathematics without any link to lack of enjoyment or irrelevance to career as the reason for not choosing A-level Mathematics.

a) The irrelevance of Mathematics to their career choice

An A-level student, currently studying Sport Studies, Biology, English Language and Geography, when asked why he did not choose A-level Mathematics despite doing well in the subject at GCSE level stated:

> *Ammish: '…. And it was never something I was going into as a career. I have always liked sports and that has been my drive and I want to go to university to study that and Maths has nothing to do with it.'*

b) Lack of enjoyment for Mathematics

When Kwame was asked about the factors that influenced the choice of the A-level subjects he is doing now, he stated:

> *"I decided whether I would enjoy it, whether I could get the best out of it … Whether I could get the grade and achieve the best I could possibly achieve."*

Another student, Paul, in response to why he did not take A-level Mathematics explained:

> "…. *It is a case of I can do it but I did not enjoy it …."*

Equally, Ammish, despite being qualified to study A-level Mathematics, chose not to because of a lack of enjoyment for the subject:

> *"I think it was one of those things I sort of did it at GCSE because I have to but I didn't really enjoy it."*

Joseph further supported this theme, when asked why he did not do A-level Mathematics he said:

> *"I was quite good at it but it was not something I enjoyed …."*

Kwame, who is currently studying Geography, Economics, Physics and Art, stated that:

"The reason why I didn't choose Maths is that I found it quite difficult at GCSE level, some of the work was hard and challenging ... and at A-level I felt that it would be too difficult and too challenging so I didn't want to take it on and not get a good grade in it ..."

c) Difficulty level of Mathematics

Kwame is studying physics, which often goes hand in hand with Mathematics at A-level, further stated that:

"…. Physics is quite difficult for me so I will be dropping it … I struggle with Physics this year. I think a lot of that is down to my mathematical ability ...."

Similarly, when Joseph was asked why he did not take A-level Mathematics, he said:

"…. it was a subject I always had to work harder at ... Even though I had a good grade I always found it very difficult."

2. Female students' reasons for not choosing A-level Mathematics

As shown in Table 17 above, two of each of the female students' views were identified under the three themes. Further analysis revealed that unlike the male students' views, no one particular reason dominated the female students' motives for not choosing A-level Mathematics. One student cited irrelevance of Mathematics to career and lack of enjoyment, the other said Mathematics was irrelevant to her career choice and found it difficult. The third and fourth students only cited one reason each, which were, respectively, lack of enjoyment and difficulty in Mathematics.

a) The irrelevance of Mathematics to their career choice

Juliana, who achieved an A* in GCSE Mathematics and wishes to study Law at University, does not think Mathematics is necessary for her career. In response to the question "*why did you not choose A-level Mathematics?"* she answered:

> *"I felt like I was better at the Arts subjects and the degree I want to do, I could do Maths for it but I thought that doing arts subjects could be more relevant and it could give me better skills to go on to study it [Law] at degree level …."*

b) Lack of Enjoyment for Mathematics

Beatrice, a female student studying Science at A-level but not Mathematics, said:

> *"I picked subjects I enjoy. I didn't mind Maths but I didn't particularly find it exciting. I was influenced by how I enjoy the subject than how useful it is."*

Juliana also acknowledged that even though she was good at Mathematics she never liked it:

> *"I felt that I had natural ability towards Arts subjects but Maths is a subject I had to work hard at but I did not like or enjoy it."*

Juliana's view indicates that good performance in Mathematics does not necessary imply enjoyment of the subject.

c) Difficulty level of Mathematics

One of the female students, in response to the question "*I learnt you did very well in GCSE Maths, why didn't you do A-level Maths?"* said:

> *Afua: "Yes ... because I did a bridging course in year 11 ... (a Maths course between A-level and GCSE) and I found that really hard and I did not do well in that paper. I therefore thought Maths*

was not going to be for me ... I find it difficult; I always have to work very hard to get a good grade in Maths."

Oparebea, on the other hand, did enjoy Mathematics at GCSE but found it difficult as well as unnecessary for her career interest:

"I did enjoy Maths when I was doing my GCSE even though I struggle with it. It did not also fit into what I wanted do …."

In summary, the factors influencing the choice of A-level Mathematics from the perspective of students who were already studying the subject at this A-level suggest that, both male and female students were influenced by the perceived relevance of Mathematics to their career choice, enjoyment and previous performance in Mathematics. Even though students did not acknowledge the direct part teachers and parents played in their choice of Mathematics, they did acknowledge support and encouragement from these sources, indicating that parents and teachers could be influential in the choice of A-level Mathematics. On the part of students who could have studied A-level Mathematics, lack of confidence and the perceived irrelevance of Mathematics to their future career choice were among the factors that affected their choices. The views of Oparebea, who did enjoy Mathematics but struggled with it at GCSE, suggested that enjoyment alone was not enough to ensure continuous study of Mathematics.

5.2.3 Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level

The significance of this section is to address research questions one, two and four as stated at the beginning of this chapter. Teachers' perspectives about gender and the choice of Mathematics at A-level are classified under five major themes. These themes are based on students':

a) Level of participation

b) Level of performance

c) Approach to learning Mathematics

d) Attitudes towards learning Mathematics

e) Level of confidence.

a) Level of participation

Teachers in School A noticed that gender differences in participation in Mathematics do exist. In their view these differences in participation change from year to year. It is not consistently in favour of one particular gender group. In response to the question; *“Have you noticed any differences by gender in participation in your school?”* Teacher Lisa stated:

> *“I don’t think it is as noticeable here as they tend to say. My year 12 group this year is very boy-heavy but my year 13 group was probably more girl dominant in year 12, about equal now in year 13. There is an equal split. I suppose we do tend to still think of [Maths] being a boy thing but it isn’t.”*

Similarly, teachers in School B do not see any clear gender differences in Mathematics participation. Responding to the question of whether he has identified any differences in gender participation in Mathematics, teacher Mathew stated:

> *“…. If I think of my A-level Maths group, there is roughly the same number of boys and girls. Boys do tend to marginally outdo them….”*

School C, on the other hand, have seen more boys than girls do A-level Mathematics. In response to the question of whether she has identified any differences in gender participation in Mathematics, teacher Diane stated:

> *“…. in my current further Maths class I have got 18 students, 3 girls and 15 boys.”*

Diane, in explaining why she thinks her class has more boys than girls, stated:

"…. I think there are [a] significant number of boys who find that Maths is their biggest strength. It's not to do with being particularly good at Maths but it is actually that they are not good linguistically and so they will opt for Maths."

She further explained:

"…. Again the number of girls, if I think of the strongest girls that have chosen not to take Maths at A-level it's not to do with not being good at Maths, it's not about not liking Maths, it's more to do with the pull of the other subjects they want to study."

Roger, who was in charge of distributing the questionnaires in School A, admitted he had not noticed more girls than boys dropping Mathematics after GCSE despite both gender meeting the required grade for A-level Mathematics. He stated:

*"…. It's funny actually, we've almost got both, you gave me the questionnaire for those who could have done A-level Maths but chose not, they were mainly girls. I looked down the list most of the ones that have got 'As' or 'A*s' are doing A-level Maths, male or female. There are a couple of girls and boys who didn't. When you look at grade 'Bs' there are a lot of students, boys predominantly … have gone on to do A-level Maths and the girls haven't …."*

b) Level of performance

Despite the differences in gender participations, teachers have found that there are no differences between the performance of girls and boys at A-level and that in some cases the girls do better than the boys.

Lisa, in referring to her A-level class, explained this point:

".... There are a lot of strong mathematician[s] who are girls, whether they are discouraged at any point I don't know …."

According to Lisa, even with the years that boys are in the majority their dominance is not translated into performance. In explaining this point Lisa stated:

> "…. *I worked with [the] statistics group who are actually doing triple award science and there are about 30 boys and about 15 girls in the group and the girls are … [on a] par with the boys' in [terms of] performance."*

Roger also stressed the non-existence of differences in performance in School A:

> *"….That is definitely something we found over the last 3 years, that the girls and the boys on average perform in a similar way…."*

Maxwell also stated:

> *"…. I think in the days where we used to do Maths coursework in GCSE, girls did tend to do better in the coursework side than boys. Now the course work has gone I don't think there has been a significant drop in the performance of girls in GCSE compared to boys in this school … I have not noticed any shift."*

Diane has also observed that despite boys being in the majority in her A-level further Mathematics class, the girls' performance is better than the boys:

> *"…. Some of the stronger Mathematics students I have taught have been girls and in my current further Maths class I have got 18 students 3 girls and 15 boys but in tests the girls outperform the boys. All three of them outperform the boys.…"*

c) Approach to learning Mathematics

In all three schools, teachers perceived differences in the way boys and girls learn Mathematics. When teacher Lisa was asked if there was any difference in the way students of different genders approached Mathematics, she answered:

".... I don't know other than girls still tend to like the project. In the statistic group we have just done their coursework now called controlled assessment and there are some of the boys who have produced lovely things but the boys tend to try and skip a little bit in the same way the girls prefer those kind of subjects because there is English there, History, Geography and those are more girl-dominant …."

Roger, in response to the same question, said:

"Girls tend to be more structured and methodical in their work and boys tend to be more haphazard with it. That has implications on what happens later on, in A-level girls write down too much, boys do not write down enough. So you try to strike that balance, obviously there are always people the other way round but in general that is what I have found."

Charles also stated:

"...what I have found out is when it comes to concentration, taking time with the work and setting out work the girls are better whereas the boys want to get to the answer very quickly often they want to do it in their head and just write down the answer. So I will say the girls are more meticulous than the boys."

Jonathan, in distinguishing between boys and girls in the study of Mathematics at GCSE level, stated that:

"…. Girls tend to like repeated examples which are the nice neat examples they have got that they can go through from the book. They like to do a lot of it … they like to repeat a lot whereas the boys tend to understand it but they don't like to write a lot of it down. They just want to write the answer down."

Jonathan's view on A-level Mathematics is that:

"When you're on A-level a lot of the girls succeed on A-level in their organisation and writing lots of examples. What a lot of the lads (i.e. boys) fall flat on is not doing a lot of examples and making mistakes

because they haven't worked it out. They just found the answers and just race through stuff."

Diane: "…. I think generally speaking girls approach Maths differently to boys but not always. I think that's more a gender difference than a Mathematics difference …. With my present further Maths group the girls are more conscientious and consistent in their approach than some of the boys. Whereas the boys may be equally capable [but] they didn't apply themselves in the same way."

In School A in particular, the perception of differences in the way in which males and females approach learning Mathematics has influenced the way the school classify their top-set Mathematics class at GCSE level. The school has three top-set GCSE Mathematics groups; both mixed gender and single-gender classes. The single-gender classes comprise of boys only and girls' only classes. When Roger was asked about what had led to these groupings he answered:

"…. We perceive the differences in the way boys and girls were approaching Mathematics at that level. I spoke earlier about boys being prepared to put their hands up to get involved and girls less confident (but not always) to do so."

He further explained:

".... Take the girls out and put them in one class, the girls have been much more forthcoming in terms of putting their hands up and getting involved in the lesson. Equally in the boys' group they are not playing up to the girls, they are not showing off which often happen in that type of class."

Question: *What criteria do you use to group the single-gender students?*

Roger: "They are not always students that love Maths in those groups but they are able. They are good mathematicians but they don't always choose to engage in the work and so you end up with students whose *potential are A or a B but not C because they are not working, they are messing about and showing off."*

Roger elaborated:

"I have got [a] girls class in year 10 at the moment and what I am seeing is students who were lacking in confidence at [the] start of the year … increasing in confidence now and are meeting and beating their target grades already … because there is now an environment that is more tailored to their needs."

d) Attitude towards learning Mathematics

Six out of the seven teachers who took part in the interviews perceived differences in gender in relation to attitudes towards learning Mathematics. In response to the question of whether there are any differences in attitudes towards learning Mathematics, Mathew takes the view that irrespective of gender, attitudes of students at GCSE are different from that at A-level. In explaining this point, he stated:

"…. Students in general don't see the point in the Maths they have been taught at GCSE. They do not understand when it is used in the real world until you point it out to them. They don't see the relevance of it at all. They just see it as a subject that they have to do and it's not until you actually point out to them where in the real world this bit of Maths is used that they see the point and even then they will say "well I'm never going to do this"."

On students at A-level, teacher Mathew explained:

"…. A-level students are more able mathematician than at GCSE and they do understand how Mathematics is a science subject that is useful in lots and lots of areas and they do understand that with the information technology age Mathematics is more important not less."

Jonathan, on the other hand, stated:

> *"…. Further Maths kids have a higher take than girls, a lot of it has to do with the competitive nature that boys have. When they get to a Maths challenge they are always competing with each other. The girls do not only like to know how to get answer but they like to understand how they got the answer. A lot of the girls aren't quite as competitive [but] are more kind of supportive of each other I think it does push them on ...."*

Mathew also stated:

> *"The girls tend to go for social sciences or biology and they do not relate to Maths …."*

e) Confidence

Two out of the seven teachers associated higher confidence in boys than girls in learning Mathematics.

> *Lisa: "So I suppose if you have a top set where it was boys' dominant that might have a negative effect on the girls. If they are not confident individuals then they feel they are not as good when actually they are equally good."*

> *Roger: "…. Boys are more prepared to put up their hands and have a go in class, girls want more confidence. That is why I think people think boys are more suited to Maths because they are prepared to have a go. Sometimes that is what it's about. It's about trying it and that's where the perception may have come from, wrongly or rightly."*

Teachers' perceptions about gender and the choice of Mathematics at A-level vary from one teacher to another, and from school to school. Not all schools perceived the existence of gender differences in participation at the A-level Mathematics. Where teachers acknowledged that gender differences do exist, they are of the view that they do not always tilt toward any one particular gender all the time. On performance, none of the teachers acknowledged a distinct existence of gender differences at A-level.

5.2.4 Students' perspectives about gender and the choice of Mathematics at A-level

Four main themes were identified from the in-depth interviews.

i. Gender differences in preference of subjects
ii. Gender-dominated professions
iii. Gender differences in enjoyment of subjects
iv. Threat of stereotype.

i. Gender differences in preference of subjects

When Adams was asked why he thought more boys than girls study A-level Mathematics he explained:

> *"I suppose girls have got different interests … subjects like textiles which are more appealing to girls than boys."*

ii. Gender-dominated profession

Paul is of the view that Mathematics is a subject which is a tool for most male-dominated careers. When asked about his view in relation to Mathematics and gender, he said:

> *"Subjects like architecture [and] engineering are more male heavy and they all require Maths."*

Paul's view was also shared by Isaac who stated:

> *"There are a lot more male Maths teachers in our school than female teachers and even in my previous school .... I have been to a few places in London and the architecture if you go in there it is literally 90% male."*

iii. Gender differences in enjoyment of subjects

Sandra, a female student studying A-level Mathematics, when asked about why fewer girls are studying A-level Mathematics stated:

> *"Girls don't like Maths … I know a lot of my friends … they were working hard towards GCSE but they did not like Maths ... For me if you don't enjoy it you are not going to take it further."*

iv. Threat of stereotype

Under the theme threat of stereotype, sub-themes were identified from students' perspectives about gender and the choice of Mathematics at A-level:

a) Students who associate Mathematics with males

b) Students who have never seen Mathematics as a male-dominated subject.

a) Students who associate Mathematics with males

The views of some students suggest that irrespective of gender there are students who still associate Mathematics with the male. For instance, when David was asked about his views about Mathematics and gender he stated:

> *" I don't know, but if someone said 'Maths' to me I kind of imagine it is a male subject but when I look back there is no real reason to think that …."*

When Adams was asked about his views on gender and Mathematics he stated:

> *"…. I have always kind of thought boys were better than girls at Maths and that girls are better at English. But in my Maths class I have got five girls and two boys."*

Question: Do you still hold to these perceptions or it has changed? If it has changed what brought about the change?

Adams: "I don't know ... I am not sure but in my family it is still like that. The boys are good at Maths. My brother did Maths at A-level and my dad is quite mathematical minded. My step family again my step brother is good at Maths the girls are not really mathematical-minded [sic] they are more English-minded so I guess that is where my conception is coming from."

Adams' view suggests that despite what he experiences in his class, which conflicts with his views, what he has identified in his family has a strong influence on his perception.

When Sandra was asked "*Have you had any perceptions or belief about Maths?" she replied:*

"Its [a] boys' subject, you don't get many girls."

Question: What brought about this perception?

Sandra: "Boys are always better than girls."

Question: Do you still hold on to these perceptions or has it changed?

Sandra: "I still think, but I just want to do it anyway. Even if it is boys' subject I just want to do it anyway."

b) Students who have never seen Mathematics as a male-dominated subject

There were still other students who have never seen Mathematics as a male-dominated subject. For instance, when Afua was asked: "*What are your views about Mathematics and gender?"* he responded:

"I didn't really have one. I always thought science is generally more male but Maths is more even. I never thought of it as a boys' subject or as girls' subject."

The views expressed by students suggest that stereotyping of Mathematics as a male subject still exists among students. There are female students who wouldn't be deterred from studying A-level Mathematics, but there are others, such as girls from Adams' family, who could be discouraged from studying A-level Mathematics as a result of these perceptions.

5.3 The Theoretical/Conceptual Framework

The General Model of Academic Choice, which is the theoretical framework for this study, is based on the effect of cultural and social environment on the choice of academic subjects (Chapter 2). Within the cultural and social environment, the model identified a lot of factors influencing the choice of academic subjects. Among these are: beliefs and behaviour; a person's perception; career choice; previous achievement-related experience; personal and social identity and the person's self-concept and expectation of success. The theoretical framework shows links, for instance between belief and behaviour with a person's perception. Due to the ties between the factors identified in the framework, the goals of students, for example, can be the direct influence of students' social perception and attitudes. Perception can also be influenced by social environment and cultural upbringing. Belief and behaviour can be shaped by social construction and reproduction of gender (Berkowitz et al., 2010). As a result, attributing factors contributing to students' choice of A-level Mathematics to just one or two particular causes did not happen in my study. Each individual gave more than one reason for their subject choices in their responses.

In comparing the analysis of the students views' on the factors influencing the choice of A-level Mathematics with this model, factors such as career choice, past performance of students and parental influence have a direct link with the model. However, factors such as enjoyment of Mathematics and prestige did not feature in the model. Similarly, the views of teachers show a link between performance, enjoyment and academic choice, but the model did not make any link between enjoyment and students' academic choice. These notwithstanding, there were differences in relation to gender and the choice of Mathematics. For example, previous performance in Mathematics is more of a factor in male students' decisions than female students. Female students, on the other hand, are influenced more by how much they enjoy the subject (Figure 12). It can also be inferred from the model that the decision of students to opt for A-level Mathematics is not only influenced by achievements and ability but also by stereotyped gender-defined jobs. This is evident in the statements of the students as identified under section 5.1.2. In the next chapter I discuss in detail the findings of the study in relation to the model vis-a-vis the whole literature review.

5.4 Conclusion

The main purpose of this chapter (analysis stage 2) was to address research questions three, four and five. From the perspective of students who had already chosen A-level Mathematics, factors which influenced their choice included the relevance of Mathematics to career choice, enjoyment and previous performance in Mathematics, parental and teachers' influence. For students who qualified to study A-level Mathematics but chose not to, lack of confidence and the irrelevance of Mathematics to their future career were among the factors affecting their choices. The analysis identified similarities in the reasons cited by both male and female students contributing to the factors influencing the choice of A-level Mathematics. For instance, the analysis has found that better performance in GCSE Mathematics does not necessarily lead to choice of Mathematics at A-level for the female student, whereas this can be the case for male students. For the female students if the high performance is as a result of enjoyment of Mathematics then they are more likely to study A-level Mathematics (Figure 12). Teachers' acknowledged gender differences in participation in A-level Mathematics but observed no clear differences in performance by gender at A-level. Teachers saw female students as meticulous when presenting their work in Mathematics at both GCSE and A-level. Stereotyping of Mathematics as a male subject was observed among students.

CHAPTER SIX: Discussion

This study set out to investigate the factors influencing student choice of Mathematics at A-level from a gender perspective. This chapter discusses the findings from the analysis of the secondary data (Chapter 4) and the primary data (Chapter 5) in relation to the literature review (Chapter 3). This is done in order to respond to the following research questions:

1. Are there any differences in examination performance in Mathematics between boys and girls at GCSE?
2. Are there differences in the number of boys and girls pursuing A-level Mathematics?
3. What factors influence the choice of Mathematics at A-level?
4. What are Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level?
5. What are students' perspectives about gender and the choice of Mathematics at A-level?

The structure of this chapter and the sections and sub-sections are guided by the research questions and the findings in the analysis.

6.1 Gender differences in examination performance in GCSE Mathematics

The analysis of the statistical data published by the Joint Council for Qualifications (JCQ, 2012) revealed gender differences in the examination performance in Mathematics at GCSE level. The data showed that between 2005 and 2011 (Chapter 4, Section 4.1, Figure 2) in each year more girls than boys studied GCSE Mathematics. Based on GCSE grades A*-B (the level required to study A-level Mathematics) and within the same time period, the number of girls who qualified to study A-level Mathematics has consistently been higher than the qualified number of boys (Chapter 4, Section 4.1, Figure 3). In GCSE Additional Mathematics, on the other hand, girls' participation was lower than that of boys throughout the period (Figure 4). Despite greater male participation, better performances have not always been in favour of the boys. For instance, in 2005 97.9% of the girls passed (A*-E) as against 97.1% of the boys, but by 2011 only 90.5% of the girls achieved these grades, compared with 91.8% of the boys. The data (Figure 4) also revealed a general decline in participation in Additional Mathematics from 2005 to 2011 for both boys and girls.

6.2 Gender differences in participation in Mathematics at A-level

The analysis in Chapter 4 shows that A-level Mathematics was male-dominated. Between 2005 and 2011 the data shows that, on average, 60% of the A-level Mathematics students were male. The gender imbalance increased when it came to A-level Further Mathematics. Within the same period A-level Further Mathematics had on average 70% male participation as against 30% female. The higher participation rate of males in A-level Mathematics did not, however, result in a correspondingly better performance. In fact in both A-level Mathematics and Further Mathematics, the proportion of female students who achieved grades A*-E from 2005 to 2011 was greater than the proportion of male students. One of the aims of this study is to discover the factors influencing the choice of Mathematics at A-level. Firstly, if performance at GCSE Mathematics alone is a factor, then I would have expected more girls than boys to study A-level Mathematics. Secondly, if participating girls in A-level Mathematics have been underperforming then it is possible to cite non-performance of girls in A-level Mathematics as a factor discouraging other girls from studying A-level Mathematics. In both instances, however, this is not the case. According to the General Model of Academic Choice (GMAC), previous performance in Mathematics could lead to continuance of study in Mathematics at A-level. This assertion leads me to conclude that girls' performance in Mathematics at GCSE level alone does not necessarily influence their decision to study A-level Mathematics. There is no evidence in this study to indicate that girls at GCSE level are aware that, on average, the performance of girls in A-level Mathematics and Further Mathematics is better than their male counterparts. When one female A-level Mathematics student in the sample was told this fact she could not hide her astonishment.

In conclusion, the data in my study shows that not only did girls perform better than boys in GCSE Mathematics but more girls obtained grades A*-B than boys. This notwithstanding, the participation of boys in A-level Mathematics was higher than girls. The gap between male and female participation became wider at A-level Further Mathematics. Despite more boys than girls studying A-level Mathematics, my data shows that the percentage of girls who passed was higher than the percentage of boys who did (Figure 7). This study has also found that students' decision to study A-level Mathematics goes beyond previous past performance in Mathematics.

6.3 Factors influencing students' choice of Mathematics at A-level

The various groups of participants have given me different perspectives about the factors influencing their choice of A-level Mathematics. The factors influencing students' choice of A-level Mathematics as identified in this study include past performance, enjoyment of Mathematics, career choice, cross-curriculum (an approach to teaching and learning which involves contribution from another subject), peer group influence, teacher influence, parental influence and lower level of algebra content in GCSE Mathematics (Chapter 5, Section 5.1 and 5.2).

Chatzistamatioua et al. (2013) found a strong positive correlation between performance in Mathematics and confidence. My study identified lack of confidence as a factor preventing students from studying A-level Mathematics (Section 5.1.1 (ii)). The GMAC suggested that the past performance of a person in Mathematics determined the future expectations in Mathematics and Mathematics-related careers. The findings of this study do not suggest otherwise, but do indicate that beside performance, enjoyment of Mathematics also affected students' choices. Attaining the grade required to study A-level mathematics, therefore, is not an assurance that girls will study A-level Mathematics. This suggests that improving girls' positive attitude and perception towards A-level Mathematics can be very important in encouraging higher participation in Mathematics.

My research has found that male students were influenced by their previous performance in Mathematics to a greater extent than females were, as girls tended to base their decision on whether to study A-level Mathematics on the level of enjoyment the subject gave them (Figure 12). In the GMAC (Figure 1), enjoyment of a particular course, such as Mathematics, was not considered a factor that could influence students' choices. The results of the primary research carried out in this study, however, disprove this.

Career is another determining factor in the choice of A-level subjects. This was identified from the views of both male and female students (Sections 5.1, Figure 12). 23.1% of the male students compared to 16.7% of the female students, chose A-level Mathematics because they perceived Mathematics to be relevant to their intended career.

VanLeuvan's (2004) assertion that the confidence and attitude of girls in any discipline affects their educational and career goals was confirmed in this study. For instance, a female student stated:

> *Betty: "Maths, I was going to do it no matter what. I really love Maths; there was no doubt I was definitely going to do Maths ... I like the challenge of it and I enjoy it."*

It is likely that this student's career choice could be influenced by her confidence and positive attitude towards Mathematics. It is, however, difficult to conclude that this was the main factor. Betty's stand supports VanLeuvan's (2004) study who found that girls' preference for an academic subject could be attributed to their higher levels of confidence and expectations at succeeding in it. In comparison, Betty's view suggest that if a girl has not decided on her career path, and is convinced of succeeding and enjoying Mathematics, then that girl is likely to choose Mathematics. Betty's view, however, contradicts Pociute and Isiunaite (2011) who asserted that serious level students who are undecided about their career decision-making are more influenced by attention to financial benefits. In my study, the girl's career choice can either be directed towards or swayed from a Mathematics-related career through the confidence, enjoyment and hope of succeeding in Mathematics.

On the issue of Mathematics having a link with students' interests in other subjects (i.e. cross curriculum) my study found that more boys (20.9%) than girls (14.1%) felt that they needed Mathematics because of their interest in other subjects. For instance, students whose interest was Physics felt that doing A-level Mathematics would help them. In contrast, other Physics students did not choose A-level Mathematics. One student stated:

"A-level Mathematics helps you understand Physics but not necessarily the other way round."

A different viewpoint was presented by a female Physics student who was not studying A-level Mathematics:

> *“I dislike the subject [of Mathematics] and so I chose Physics as the alternate option for [my] university application.”*

This view suggests that even though there may be strong Mathematics representation in a subject, it is not a guarantee that this will influence a student's choice of Mathematics. A student can avoid Mathematics at A-level and still remain interested in studying perceived Mathematics-related subjects.

Another issue that was raised mainly by female students was that at A-level boys are not ready to venture into other subject areas that are perceived to be 'female' subjects. Girls believed that they had more options in A-level subject selection than boys. Initially this sounded illogical since there are no restrictions as to what male students can or cannot choose, but became clearer after looking at some of the female statements. For example:

> *“Boys might be discouraged from doing ‘girls’ subjects such as Dance and Textiles so instead choose subjects like Maths.”*

“Girls tend to study scientific subjects as well as arts subjects, boys sometimes stick to one area.”

Perceptions of how masculine or feminine certain A-level subjects are considered does not fall within the scope of this study but it would be interesting to know how this affects subject selection at A-level. Nevertheless, in this study female students are of the view that the smaller number of girls than boys studying A-level Mathematics has nothing to do with female students' inability to study A-level Mathematics. It can, however, be inferred that the higher pass rate of female students than male students at the GCSE level in other subjects beside Mathematics gives them wider options than male students at A-level.

An unexpected factor that arose from this study is that peer group does influence learning Mathematics, either positively or negatively, but not in relation to the selection of Mathematics for further studies. Steffens and Jelenec (2011) identified five areas that can affect the perceptions of peer groups: achievement, motivation, decisions, behaviour and beliefs. Similarly, some of the teachers in this study were of the view that the peer group could influence attainment, motivation, behaviour and decisions. This is also consistent with another study, by Robertson and Symons (2003), in which it was found that peer group did influence attainment. Mathew, a teacher in this study stated that:

"At A-level, friends tend to help each other but at GCSE it depends on the social group the students find themselves in …."

Research relating to parental influence found that the higher the parents' level of Mathematics (i.e. A-level and beyond) the more likely they were to influence their children to study Mathematics to a higher level (Table 12 and Table 14). The results also suggested that girls were more likely than boys to progress further with Mathematics if their parents' level in Mathematics was higher and less likely if their parents' level of education in Mathematics was below A-level. The GMAC neglected to consider the background of parents as a factor influencing students' choice of Mathematics.

A study by Noyes and Sealey (2012) found that prior to students embarking on a period of advanced level study, Mathematics teachers had greater influence on their choices than when they were already at A-level. The findings of Noyes and Sealey are firmly supported by this study. For instance, examples were found of students being advised against studying A-level Mathematics by teachers because, in their view, such students would not cope with advanced level even if these students had attained the required grade for studying A-level Mathematics. One teacher argued that in order to cope with the A-level Mathematics course students should have a strong foundation in algebra. He believed it was possible to pass GCSE Mathematics with grade A*-B and still fall short of the algebra level needed for A-level Mathematics. This not only highlights the influence teachers can play in students' A-level choices but also calls into question the Mathematics curriculum at pre A-level and its role as a preparatory course of study for A-level. Another teacher argued that at A-level teachers are judged by the performance of their students. This may explain why teachers often advise students not to opt for A-level Mathematics, as they may think there is not enough time to bring students up to the required algebra level. Since A-level Mathematics and beyond involve higher levels of algebra, it would be appropriate for algebra to be introduced earlier in the curriculum. Gracia's (2012) study of college algebra in the Philippines found that male students were better at college algebra than female students. This may give some indication about a possible 'gender trend' in algebra performance. If this trend is applicable in the UK, the high algebra content of A-level Mathematics means male students should be performing at a higher level than female students, but this is not the case. The few female students who continue with A-level Mathematics perform better than males. It is more likely that the perceived low level of algebra in the GCSE curriculum contributes to a lack of confidence in studying A-level Mathematics for both genders. The low level of algebra at GCSE level could explain why there is a higher dropout rate at the beginning of the A-level Mathematics course, as identified by Noyes and Sealey (2012).

Encouraging greater participation in A-level Mathematics should begin before GCSE level. As suggested by a teacher in this study, if at A-level a student has not already developed an interest in Mathematics there is little teachers can do to help stimulate students due to the time constraints they are under. Teachers are therefore unlikely to encourage any students to embark on A-level Mathematics if they think they will be unable to cope with the demands of the curriculum at advanced level.

During the course of this study it was also found that GCSE Additional Mathematics, which has a higher level of algebra than standard GCSE Mathematics, had a low level of participation for both genders, but particularly females. It is difficult to draw any conclusions from these results as a pass in GCSE Additional Mathematics is not a criterion for studying A-level Mathematics, it simply gives the student a head start. However, the data presented in Figures 2, 4, 6 and 8 confirms Mendick's (2005) assertion that the less compulsory Mathematics is, the more gendered it becomes.

6.4 Social construction and social reproduction of gender

In accordance with the views of Stuber et al. (2011) this study identified a continuous process by which gender differences were perceived and taught through interactions within the family and the schools' settings (Sections 5.1.2, 5.2.3 and 5.2.4). The teachers' and students' perceptions of gender are born out of a socially constructed view about gender (Butler, 2007). Similar to the study of Chang et al. (2011) this study also identified the continuous dissemination (i.e. social reproduction) of these gender roles through the process of socialisation (Sections 5.2.3 and 5.2.4).

6.4.1 Teachers' perspectives about gender and the choice of Mathematics at A-level

Gender construction (the means by which gender differences are seen and imparted within social settings) was identified through the way teachers explained differences in student participation in A-level Mathematics. Some teachers perceived that male students appeared to be more confident in Mathematics class than female students, as reflected in male students' readiness to ask and respond to questions in class. However, it is not appropriate to judge the students' level of confidence in Mathematics only through outward responses in the classroom. In School A for instance, teachers believed that gender differences in student participation in classroom activities or in open responses to teachers' questions changes in different years. Girls' confidence in Mathematics was found by VanLeuvan (2004) to have a direct influence on their attitude towards learning Mathematics. Therefore, any issue that affects the confidence of girls towards Mathematics affects their attitude towards the subject as well (VanLeuvan, 2004). As a teacher in School C explained: a girl graded ‘B’ in GCSE Mathematics may not think this grade is good enough to study A-level Mathematics, whereas a boy with the same grade may be prepared to have a go. Similarly, a teacher in School A explained that due to the fact girls generally perform better than boys at GCSE level in a range of subjects a grade 'B' in GCSE Mathematics for a girl may not necessarily be one of her best grades but for a boy this same grade may be one of his best results. In this situation the boy’s options are more restricted than that of the girl’s.

Some of the teachers in the study perceived differences between male and female students’ approaches to learning and answering questions. For instance, one teacher stated:

> *“Girls tend to be more structured and methodical in their work and boys tend to be more haphazard with it. That has [an] implication on what happens later on. In A-level, girls write down too much [whereas] boys do not write down enough. So you try to strike that balance, obviously there are always people the other way round but in general that is what I have found.”*

Hargreaves et al. (2008) believe that in Mathematics the attitudes of teachers and parents are usually a reflection of the stereotypical idea about superiority of males over females. Even though the teachers in this study had found differences in attitude between male and female students towards learning Mathematics, there was no evidence that these differences reflected the teachers' stereotypes regarding superiority in terms of performance of one gender over the other.

6.4.2 Students' perspectives about gender and the choice of Mathematics at A-level

In accordance with the views of the teachers in this study, the students also believed there were gender differences in preference of subjects (Section 5.2.3 and 5.2.4). According to Jarvela and Järvenoja (2011) students' perceptions are thoughts, beliefs, and feelings about the persons, situations and events which have been influenced by their past experiences. Social factors, therefore, influence the choices students make in their subject selection. One such factor is the domination of specific professions by one gender. One student stated:

> *Paul: "Subjects like architecture [and] engineering are more male heavy and they all require Maths."*

The social construction of gender is a continuous process among the students. Examples of gender-stereotype statements that are being formed include:

> *"Boys mostly study science and engineering which are linked to Maths."*
>
> *"It is considered to be more of a boy's subject due to traditional views."*
>
> *"Boys stereotypically will do engineering requiring Maths."*
>
> *"Boys might be discouraged from doing 'girls' subjects such as dance and textiles so instead choose subjects like Maths."*

The students in the sample were of the view that at GCSE level in general, girls are more serious with their learning than boys. These are some of the reasons cited for male students underperforming in GCSE Mathematics:

> *"Girls have better concentration [so are] more likely to revise and [are] more organised."*
>
> *"I believe there are more mature girls than boys … mature pupils do more work and this gets them higher grades."*
>
> *"Girls try harder but are not interested in Maths."*
>
> *"Girls may be naturally more clever [sic] and may also work harder."*

"Girls can generally be more systematic and organised with work which I think is necessary to gain full understanding of Maths."

"…. girls know that they are rubbish [and] therefore work harder."

The above responses show a positive image of girls towards learning in general. These positive images about girls can thus contribute to a positive learning environment which can affect both genders, especially where the number of girls is greater than boys. These findings are in support of Lavy and Schlosser (2011) who attributed the enhanced performance of both boys and girls, where the population of girls was more than boys, to less distractive and less violent classrooms. The above responses from both male and female students also provide evidence of the existence of gender stereotyping, but do not provide evidence that the process is continuous.

In the 1980s female students were classified as being weaker in their mathematical abilities than male students (Steele, 2010). However, the findings of this study refute that (Figures 5, 7 and 9). The improvement in the female students' mathematical abilities is, however, not reflected in the proportion of girls to boys studying A-level Mathematics.

6.5 Model for choosing A-level Mathematics

My study has been guided by the General Model for Academic Choice (Figure 1). The model's starting point is based on:

a. Social role stereotype
b. Cultural stereotype of subject matter and occupational characteristics
c. Family demographics.

According to the model, within these factors are other factors such as achievement, competency, gender-role values and long term planning, as factors influencing students' choice of further studies in Mathematics (Eccles, 2011a). Similarly to the model, several factors have been identified in this study as influencing students' choice of A-level Mathematics. These are:

i. Attitude and perception
ii. Enjoyment of Mathematics
iii. Previous performance in Mathematics
iv. Importance of Mathematics to career
v. Link with other subjects of interest
vi. Curriculum gap
vii. Peer group influence
viii. Parental influence
ix. Teacher influence
x. Threat of stereotype.

The social role stereotype identified in this study was Mathematics as a subject associated with male-dominated careers. For example, careers in architecture and engineering were perceived as male-dominated careers which required Mathematics. The issue of cultural stereotype was not prominent in my study as data on participants' cultural backgrounds was not collected.

There are instances where the GMAC is not clear in its emphasis on some factors. For instance, this study found that a girl was more likely to study A-level Mathematics if her good performance arose as a result of previous enjoyment of Mathematics. The model, on the other hand, did not take into consideration enjoyment of Mathematics as a factor influencing the choice of a subject. My study confirmed the model's proposal that a girl's previous performance in Mathematics had less influence on her choice if she felt that she had to put in more effort to be able to pass (Eccles, 2011).

6.5.1 Limitations of the General Model for Academic Choice

The GMAC, as discussed in Chapter 2, is a social model rather than a scientific model. The complex nature of human beings makes it difficult for a social model to work without limitations. Even though the model played an important part in this study there were some limitations with it. Firstly, the model does not suggest a cause and effect relationship between factors and outcomes. For instance, the evidence presented in this study suggests that Mathematics is still stereotypically a male subject which leads to stereotypical male-dominated careers. The model suggests stereotyping as a factor influencing students' choice of academic subject but did not suggest the cause of the stereotyping.

It is difficult for the model to identify and define human thought and decisions. When used for this study, the model did not recognise the influence of teachers on students' choice of subjects. One particular view of the teachers not captured by the model was the wide gap between Mathematics curriculum at GCSE and at A-level and how this affected gender participation in A-level Mathematics. The model has therefore oversimplified the complex socially constructed live experiences of gender-role stereotyping in the society. Other findings that could not clearly be deduced from the model included the fact that a girl who enjoys Mathematics but has not yet decided on her career is likely to continue to study Mathematics. Despite these inconsistencies, the findings of this study did not show a great departure from the model.

6.6 Conclusion

In conclusion, previous performances in Mathematics appear to have played a role in the choices that students make. Whereas this seemed to be a major factor for male students, it was less so for female students. Previous good performance in Mathematics can lead to enjoyment in the subject, but enjoyment may not necessarily lead to good performance.

In addition to the factors identified above, the issue of the GCSE curriculum content concerning the gap between GCSE and A-level Mathematics curriculum also emerged. In my view this is an issue of national significance. Even though this study only represents a very small number of respondents on the subject, the consistency with which this issue was emphasised highlights its significance. The wide gap between GCSE Mathematics and A-level Mathematics was attributed to the lack of depth in the teaching of algebra at GCSE level. Garcia’s (2012) study, which found boys to be better at algebra than girls, can be mitigated if algebra is introduced in Key Stages 1 and 2 and gradually built upon to the level needed for A-level Mathematics in Key Stages 3 and 4. This, in my opinion, could help build girls’ confidence in Mathematics, and subsequently improve their participation in the subject at A-level.

It was found that as much as peer group influence can be negative to the choice of A-level Mathematics, teachers can use peer group influence to improve performance. The positive or negative influence of peer groups depends on the different stages in a child's growth (Wang et al., 2013). Peer groups can have a positive influence if there are a higher proportion of girls in a class than boys. In agreement with the findings of Wang et al. (2013), this study found that peer group influence prior to the choice of A-level Mathematics was higher than at A-level. Once the student has chosen A-level Mathematics, peer group influence supports and motivates learning Mathematics.

In my view every child is a potential future parent and therefore has the ability to influence the decision of children in the future. The study found that parents whose Mathematics ability was at A-level or beyond were more likely to have a positive impact on their child’s choice of Mathematics. This gives the impression that increases in the level of A-level Mathematics participation will have a ripple effect on the future of female participation in the subject.

Teachers have a significant influence on students. These influences include the learning, motivation and choice of subjects students make. This study found that girls’ interest in Mathematics can be encouraged at different stages in educational life, especially from primary to Key Stage 4.

The study identified evidence of the stereotyping of Mathematics as a male subject. Some of the statements made by both boys and girls (Section 5.1.2) suggest that there is a continuous social construction of gender among students and within the school settings. Unfortunately some of these gender constructed views about boys and girls have become the accepted norm. This can be a contributing factor to the under representation of girls in A-level Mathematics.

Confirming the findings of McWhirter et al. (2013), this study has identified the impact of parents' expectations, gender-typed aspirations, attitudes towards Mathematics and gender stereotyping of careers as factors influencing the choice of A-level Mathematics. It is also clear that past good performances alone are not a guarantee for girls to have a positive attitude towards, or great self-confidence in, Mathematics at A-level (Sections 6.1, 6.2 and 6.3).

CHAPTER SEVEN: Conclusion

This study set out to investigate the factors influencing the choice of Mathematics at A-level from a gender perspective. The study has been guided by the following research questions:

1. Are there any differences in examination performance in Mathematics between boys and girls at GCSE?
2. Are there differences in the number of boys and girls pursuing A-level Mathematics?
3. What factors influence the choice of Mathematics at A-level?
4. What are Mathematics teachers' perspectives about gender and the choice of Mathematics at A-level?
5. What are students' perspectives about gender and the choice of Mathematics at A-level?

In this concluding chapter each research question is addressed in relation to the findings and then the literature. This is followed by a review of the current situation, based on 2012 to 2014 examination results published by the Joint Council for Qualifications (JCQ). Discussion about the original contribution to knowledge produced by this research follows this section. The strengths and limitations of the study are then considered, as are recommendations for future research, policy and practice. The chapter concludes with a reflection on my journey as a researcher, highlighting what I have learnt.

7.1 Addressing each research question

Research question 1: Are there any differences in examination performance in Mathematics between boys and girls at GCSE?

My study identified differences in examination performance in Mathematics between boys and girls at GCSE level (Section 4.1.1) between 2005 and 2011. Based on the analysis of the statistical examination data published by the JCQ (2012), this study found that in the UK not only have girls consistently performed better in GCSE Mathematics than boys, but the percentage of girls who obtained grades A*-B (i.e. the grades needed to progress to A-level Mathematics, (Figures 2 and 3) was higher than the percentage of boys who achieved these grades. These findings support the UK study by Kirkup et al. (2010) and the Dutch study by Korpershoek et al. (2011) which both discovered that girls perform better in Mathematics than boys prior to Advanced level Mathematics.

Research question 2: Are there differences in the number of boys and girls pursuing A-level Mathematics?

The results of this study revealed that more boys than girls consistently chose to study A-level Mathematics between 2005 and 2011 (Average 60% boys to 40% girls, Section 4.2, Figure 6). In A-level Further Mathematics the gap between male and female students' participation was even bigger over the same period (70% boys to 30% girls, Section 4.2.1(i)). This endorses Mendick's (2005) view that Mathematics becomes more gendered in favour of male students at progressively more advanced levels and when it becomes optional.

Research question 3: What factors influence the choice of Mathematics at A-level?

Different factors were identified in my study as influencing the choice of A-level Mathematics. The factors that were identified (Sections 5.1 to 5.2) included:

i. Attitudes
ii. Perceptions
iii. Confidence level
iv. Enjoyment of Mathematics
v. Individuals' previous performance in Mathematics
vi. Importance of Mathematics to career
vii. Mathematics being seen as a link with other subjects of interest to the students

viii. Parental influence

ix. Teachers' influence

x. The threat of stereotype.

It was found that both male and female students were influenced by these factors in the choice of A-level Mathematics, but the extent to which one gender group was influenced over the other by these factors varied. These variations formed part of the responses to Research Questions 4 and 5 below.

Research question 4: What are Mathematics teachers' perspectives on gender and the choice of Mathematics at A-level?

Teachers' perspectives on gender and the choice of Mathematics at A-level as identified in this study include gender differences in:

a) the number of students who chose to study A-level Mathematics
b) level of performance
c) attitudes towards learning Mathematics
d) confidence levels.

Teachers were of the view that the number of female and male students opting to study A-level Mathematics changed with different year groups (Section 5.2.3). There have been groups with equal representation of male and female, male-dominated groups, and also female-dominated A-level Mathematics classes. This confirms results found in earlier studies by Sutherland (1981), Arnot and Mac an Ghaill (2006) and Shapiro and Williams (2012), who all acknowledge that the emphasis on the issue of gender differences changes over certain time periods. For instance, in the 1980s the underperformance of girls in Mathematics was an issue, but this study, focussed on the years between 2005 and 2011, found that underperformance of girls in GCSE Mathematics was no longer an issue; rather it was the underrepresentation of girls in A-level Mathematics.

Referring to level of performance, the teachers in the sample did not perceive any difference in performance in Mathematics between male and female students. Yet similarly to the findings of Darling-Hammond et al. (2012), the teachers themselves felt the impact of being assessed by the performance of their students. Teachers are therefore not likely to encourage students to study A-level Mathematics if they think the student will not perform well in the subject at advanced level.

Teachers perceived differences between male and female students in terms of their attitudes and approaches to learning Mathematics (Section 5.2.3). At GCSE level, female students were perceived to have a positive attitude towards learning in general which they carried on throughout A-level. Male students, on the other hand, tended to have a negative attitude towards learning in general at GCSE level but a positive attitude became evident at A-level.

On the issue of confidence, teachers believed that students who achieved an A* at GCSE and then opted to study A-level Mathematics were confident about their abilities, whether they were male or female. Amongst students with grades A and B at GCSE level, however, boys were more confident than girls. Despite these teachers' views, my study found that out of the students who could have studied A-level Mathematics (i.e. obtained the required grade A*-B) but chose not to, 0.8% of the girls and 15.8% of the boys attributed their refusal to study the subject to a lack of confidence.

My study identified different perspectives from teachers about the influence of parents on their children's selection of A-level Mathematics. There were views which suggested that if the child had not already developed an interest in Mathematics, there was not much the parent could do to influence their child's choice of A-level Mathematics. There were others who felt that parental influence could not be ignored. Parental influence, according to this study, is mainly identified by parents seeking extra teaching support for their children in Mathematics. There was also evidence to suggest that the parents' own level of attainment in Mathematics could influence students' choice of A-level Mathematics (Sections 5.1.1(i(a)) and 5.1.1(iii), Tables 12 and 14). It was concluded that the higher the parents' level of Mathematics education, the more likely their offspring would choose to study A-level Mathematics.

Research question 5: What are students' perspectives on gender and the choice of Mathematics at A-level?

There was a general perception, from both genders, that female students had a positive attitude towards learning overall. These positive perceptions about female students, according to VanLeuvan (2004) and Chatzistamatioua et al. (2013), influence girls' performance positively. The responses of both male and female students provide clear examples of continuous gender construction within the school settings. Views such as "*Girls have better concentration, [and are] more likely to revise and more organised", "I believe they are more mature girls than boys … mature pupils do more work and this gets them higher grades", "Girls try harder but are not interested in Maths"*, are all means by which gender differences are perceived, taught and reproduced in social interactions within social institutions such as the workplace, family, schools and religious settings (Stuber et al., 2011; Doob, 2012). These thoughts, beliefs and feelings about a person or situation are some of the factors that my study identified of which VanLeuvan (2004) and Chatzistamatioua et al. (2013) consider as influences on students' choices (Chapter 2).

My study found that both male and female students perceived the importance of Mathematics to career choice as an important role in the selection of A-level Mathematics. In their view, Mathematics is 'good on the CV', prestigious and enhances job prospects (Table 13).

The risk of confirming negative stereotyping in terms of the masculinity of Mathematics was evident in my study. The performance of female students in GCSE Mathematics does not suggest any masculinity stereotyping associated with Mathematics as the performance of girls outstrips boys. However, the threat of masculine stereotyping of Mathematics was evident in girls' non-selection of A-level Mathematics as more boys than girls selected the subject. The threat of stereotype is not only associated with female students' perception of Mathematics as masculine but male students' persistence in selecting to study subjects perceived to be masculine. This study confirms the findings of Logel et al. (2012) who stated that females were more likely to drop Mathematics and select other subjects if they faced the stereotype threat. One respondent in this study argued that the overall better performance of girls than boys in subjects other than Mathematics at GCSE level gives girls more choices than boys at A-level. This, in her view, may be contributing to less female student participation in A-level Mathematics.

7.2 Current situation from 2012 to 2014

My study investigated the factors influencing the choice of A-level Mathematics from a gender perspective between 2005 and 2011 focussing on the JCQ published GCSE and A-level results data. With the aim of examining changes since 2011, a brief account is given below of the situation between 2012 and 2014 based on JCQ published results. Figure 15 shows the number of students, by gender, who took part in summer GCSE Mathematics examinations from 2012 to 2014. Akin to the data from 2005 to 2011 (Figure 2), female students' participation in GCSE Mathematics examinations have consistently been higher than male students.

Figure 15: Student participation in GCSE Mathematics examinations from 2012 to 2014.

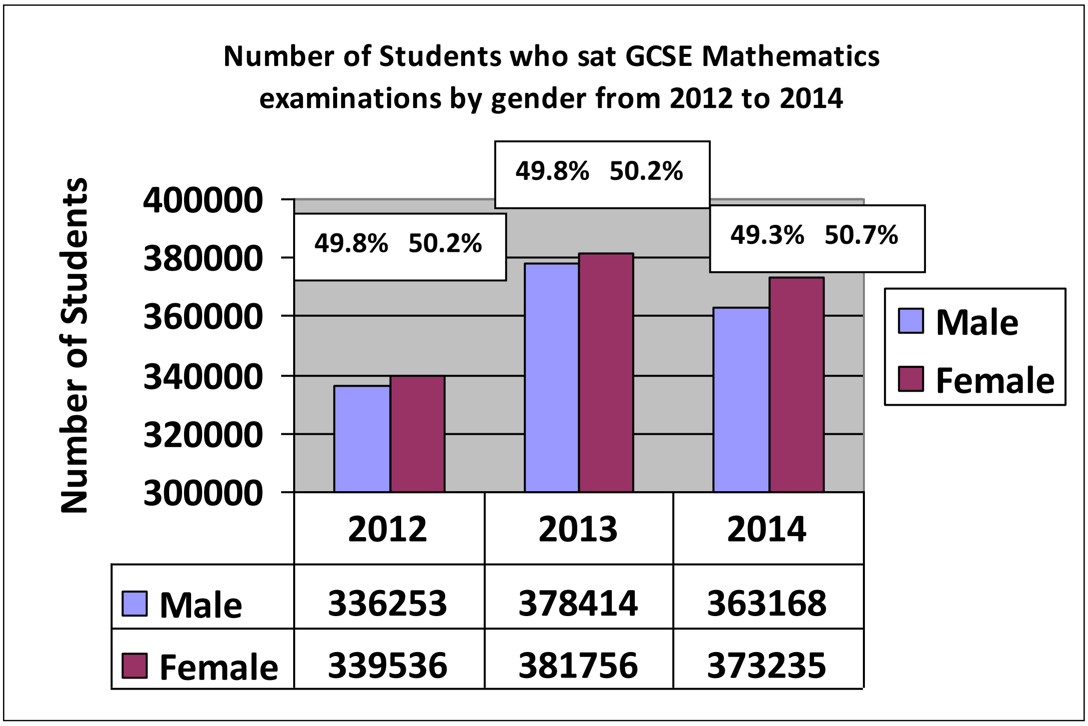


Figure 16 shows the number and percentage of students by gender who attained grades A*-B in GCSE Mathematics from 2012 to 2014.

Figure 16: Students with grades A-B in GCSE Mathematics from 2012-2014*

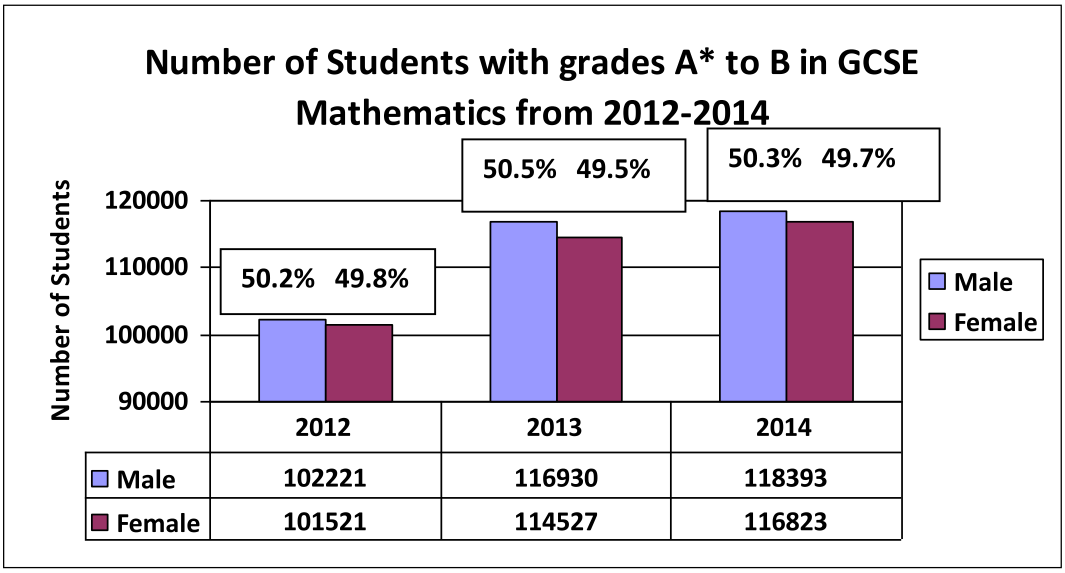


Figure 16 reveals a departure from one of the findings of this study. In comparison with Figure 3 (p. 93), Figure 16 shows that more boys than girls obtained grades A*-B (2012: 50.2% male, 49.8% female; 2013: 50.5% male, 49.5% female; 2014: 50.3% male and 49.7% female), whereas Figure 3 shows that more girls than boys attained A* to B between 2005 and 2011. Figure 17, below, shows the number of students who took part in A-level Mathematics from 2012 to 2014.

Figure 17: Student participation in A-level Mathematics (2012-2014)

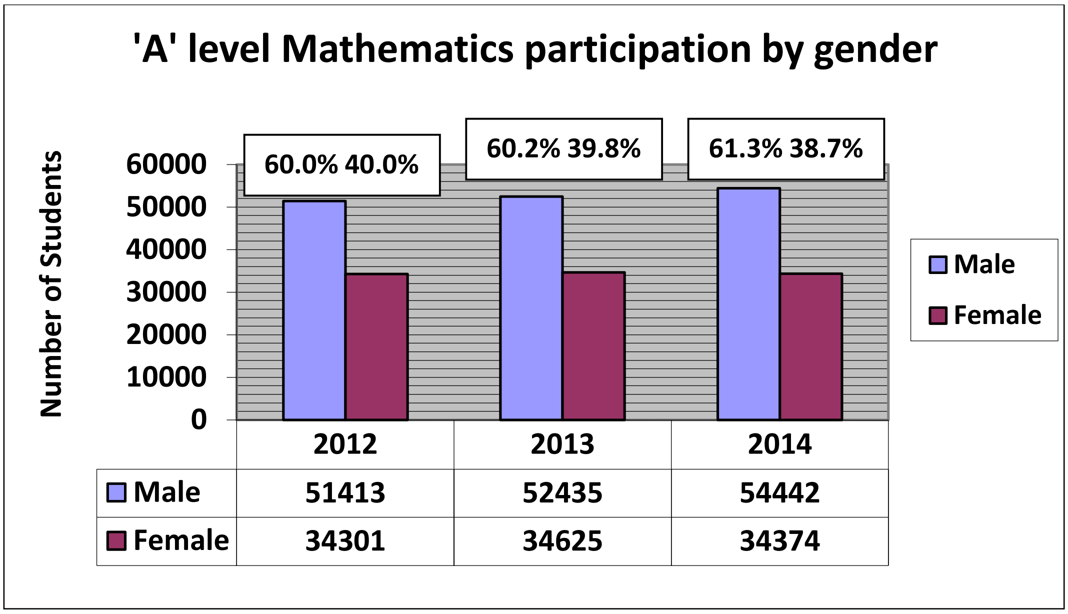


Figure 17 emphasises that the problem this study identified still persists: there remains higher male than female student participation in A-level mathematics (2012: 60.0% male, 40.0% female; 2013: 60.2% male, 39.8% female; 2014: 61.3% male, 38.7% female). The current situation shows that there is a gradual decline in the percentage of female students studying A-level Mathematics. The proportions of girls' participation, in GCSE Mathematics examinations between 2005 and 2014, were higher than boys (Figures 2 and 15). When the proportion of girls attaining A*-B grades at GCSE was higher than boys (between 2005 and 2011, Figure 3), more boys than girls studied A-level Mathematics. This current trend shows that in GCSE Mathematics examinations more boys than girls attained grades A*-B (which was the other way round between 2005 and 2011) and when coupled with the trend of higher percentage of boys than girls' participating in A-level Mathematics, emphasises the contemporary relevance of my study. One of the aims of my study was to investigate the underrepresentation of girls in A-level Mathematics and the trend from 2012 to 2014 shows the underrepresentation of girls in A-level Mathematics persists.

7.3 Original contribution to knowledge

Few studies have previously sought to investigate the reasons behind the relatively low number of girls as opposed to boys studying A-level Mathematics in the UK (Mendick et al., 2008; Kirkup et al., 2010). Studies in the 1980s by researchers such as Sutherland (1981) and Fennema (1990) simply identified girls' underperformance in Mathematics. Researchers such as Mendick et al. (2008), Hartley and Sutton (2013), Kirkup et al. (2010) and Roberts (2012) went further by identifying the issues of boys underperforming in schools across the curriculum and girls being underrepresented in Mathematics-related professions in the UK. What makes this study significant is the exploration of Mathematics as an exception to the rule that high performance equated to high participation. It was identified, in the period under study, that at GCSE level girls outperformed boys in the majority of subjects, but that in any subject in which girls outperformed boys, the proportion of girls studying a similar subject at A-level was higher than boys (Tables 1 and 2). Similarly, in subjects where more boys outperformed girls at GCSE level, more boys than girls' participated in the subject at A-level. In the case of Mathematics, however, despite more girls outperforming boys at GCSE level, more boys than girls go on to study the subject at A-level.

In exploring teachers' and students' perceptions concerning gender, this research has added to existing knowledge about the concept of social construction and social reproduction of gender within the school system. This is evident from the literature review (Chapter 2). Early research work, in the 1980s and 1990s, attributed the underperformance of girls in Mathematics to gender role theory and the threat of stereotype (Fennema, 1990; Sutherland, 1981). For example, Fennema (1990) attributes girls' underperformance to the bias of Mathematics in favour of boys. The trend in Mathematics performance between 2005 and 2011 at GCSE and A-level does not show girls underperforming but instead boys underperforming in GCSE and girls underrepresented in A-level Mathematics.

Differences in examination performance as well as underrepresentation in Mathematics of either boys or girls demonstrate a lack of equity in Mathematics education. My study sought to find the extent to which the concept of gender influenced students' choice of subjects and career. Fennema (1990) asserts that if equity in Mathematics education is achieved there should be no difference in the attainment of important educational outcomes. Fennema's view suggests that gender equity in Mathematics education equates to equal attainment grades for male and female students. This, however, seems short-sighted as even after attaining equal outcomes gender related impediments still continue to exist that prevent girls from moving to the next stage in the study of Mathematics. In my view, attaining equal outcomes at one level of education should then make possible equal participation in the subsequent phases. I am therefore proposing that the definition of equity in Mathematics education should be expanded to mean:

> *If gender equity in Mathematics education is attained, there should be no gender differences in* ***performance or participation*** *in Mathematics education at every phase of education.*

7.4 Strengths and limitations of this study

Strengths and limitations have been identified at various stages throughout the thesis. For example, the detailed methodological strengths and limitations associated with the design, sample size, informants and the process of data collection have been discussed in Chapter 3.

7.4.1 Strengths of the study

Firstly, carrying out a case study has provided focus, with concentration being on a small sample of three schools, student and teacher perspectives, and a detailed analysis of the issue of gender and the choice of A-level Mathematics.

Secondly, the primary research carried out was supported by secondary data from the Joint Council for Qualification, whose membership comprises of examination boards in the United Kingdom which have many years of expertise and professionalism in the conduct of examinations. This large dataset of students' participation in examinations at both GCSE and A-level enhances the validity and reliability of my study. Combining complementary qualitative and quantitative data (i.e. mixed methods) allowed me to enquire into both the statistical and perspectival situations pertaining to the topic, leading to insights that would not be achievable through the use of just one method.

Finally, applying the General Model of Academic Choice as the theoretical framework provided guidance for this study and helped to establish a representation between my study and real world occurrence (Robson, 2011). This was done without losing sight of Robson's caution about the tendency of models to lead to overgeneralisations of findings.

7.4.2 Limitations of the study

In the process of the literature search, I identified several factors which could affect students' choice of Mathematics other than the ones on which this study focused. These included the cultural background, race, ethnicity and religion of participants in relation to gender. I acknowledge that widening the study to incorporate cultural, race, ethnicity and religious backgrounds could have provided new perspectives about gender and the choice of mathematics. However, this could also have affected the focus of the study as within the time and word constraints incorporating too many influencing factors would have limited the depth of analysis.

Exploring in more depth the ways in which gender is constructed through interactions in educational settings and students' responses to knowledge and experiences of these interactions, including the effects on their subject choice decisions, could have added an important dimension to the study. Analysing the construction of gender in the lived experience of schooling may have provided a deeper insight into the issue concerning school subjects being categorised as 'male' or 'female' subjects and how this subsequently operates to narrow students' subject choices (Sanders et al., 2010). This was not addressed in this study as it requires a longer ethnographic study involving more in-depth interviews with teachers and students and classroom observation. This was not possible within the time available and would have caused unacceptable inconvenience to participating schools.

7.5 Recommendations for future research

As noted in Chapter 3 (Section 3.5), case study as a research design has an inherent issue with transferability, therefore similar research is required elsewhere in the UK. According to Lincoln and Guba (1985), this could encourage comparability and transferability of findings where possible.

Throughout my research it became apparent that the depth of students' knowledge of algebra gained from the GCSE Mathematics curriculum is not sufficient to make a smooth transition to A-level Mathematics. Roger a teacher in my study argued that the A-level Mathematics course hinges on algebra and therefore students who do not have a strong foundation in algebra at GCSE level are likely to struggle with A-level Mathematics. I therefore recommend that further research studies are undertaken to investigate the algebra content of the A-level Mathematics curriculum and the implications of this for the development of the GCSE curriculum. The aim of such studies would be to find out the different aspects of algebra that are employed in A-level Mathematics and the extent to which these aspects are covered in the GCSE Mathematics curriculum. Such a study could take the form of a review of the GCSE and A-level curricula regarding algebra content followed up by interviews with A-level Mathematics teachers and students with the aim of identifying aspects of algebra with which students struggle most.

A further study is also needed to enquire if algebra is perceived to be a 'gendered' topic in the Mathematics curriculum. Findings of such a study could explain or debunk some of the reasons cited in this study for less female than male participation in A-level Mathematics (Section 5.1). One teacher, Lisa, in the study stated that A-level Statistics, which is perceived to have less algebra content, appeals more to girls than Mechanics and other branches of A-level Mathematics (Section 5.2.3). A study seeking to explore this teacher's view by investigating whether A-level Statistics appeals more to female students than A-level Mechanics does, and if it does the possible reasons for this, could subsequently help to explain if algebra is related to girls' choice of A-level Statistics.

My study identified that girls are more likely to continue the study of Mathematics if their previous good performance primarily resulted from their enjoyment of Mathematics (Figure 12). However, my study did not set out to identify ways of making Mathematics enjoyable and therefore further studies are needed in this field. Primary research, therefore, is recommended to find out from students what makes them enjoy or dislike the study of Mathematics.

Some teachers suggested that gender differences in the A-level Mathematics intake can change over time. However, the evidence from the JCQ examination results (2005 to 2014) shows that A-level Mathematics participation is biased in favour of male students. Further studies, fully contextualised in school settings, are therefore needed to measure when (and if) these changes occur and to identify the causes for these changes.

One of the issues identified in the study was that as a result of teachers being assessed by the performance of their students, they were unlikely to encourage students who they felt may not perform well in A-level Mathematics to study the subject at advanced level. The extent to which this affects student participation in A-level Mathematics needs to be investigated further.

Finally, lack of confidence amongst both genders (but more pronounced in females) is one of the issues identified as preventing students from pursuing further studies in Mathematics (Section 5.2.3). A further investigation could be undertaken to identify ways of improving both girls' and boys' confidence in the study of Mathematics.

In conclusion, if I had the opportunity to undertake this research again there are certain things that I would do differently. I would incorporate classroom observation into my study in order to observe ways in which both boys and girls respond in a Mathematics classroom and how gender is constructed in daily interactions within the educational setting. I would also focus on teachers' verbal and nonverbal interactions with students and administer follow-up questionnaires involving multiple choice questions. The use of multiple choice questions as a follow up would help students to be more specific with their reasons for choosing A-level Mathematics and make it easier in the analysis to rank their choices, thereby enhancing the quality and insights of both the qualitative and quantitative data (Robson, 2011).

7.6 Recommendations for policy and practice

The findings of this study suggest some courses of action for policy and practice. One of the implications of my study for both policy makers (such as the Department of Education) and practitioners (such as teachers) is the need to widen the meaning of equity in education to include not only equality of outcome in terms of examination success but also equal representation in participation on a gender basis at all levels of education. Researchers such as Sutherland (1981) and Fennema(1990) have defined the achievement of equal outcomes as equal performance at the end of the school years. As stated above, this measurement of equality is restrictive, as the achievement of equal outcomes in terms of gender at a compulsory level does not aid gender equality in participation when Mathematics becomes optional. In my view achieving equal outcomes should occur alongside equal participation. It is based on this view that I am recommending that gender equity in mathematics education should seek to achieve equity in both performance and participation.

The plan of the UK Government is to encourage more student participation in A-level Mathematics (NCETM, 2010) but Noyes and Sealey (2012) identified a high dropout rate in A-level Mathematics among both genders at the start of the A-level courses. A government policy to encourage more girls to study A-level Mathematics could help meet the target of increasing student participation in advanced Mathematics.

As my study found that girls are more likely to continue to study Mathematics if their previous good performance is a direct effect of their enjoyment of Mathematics, exploring pedagogical approaches that will improve girls' interest and enjoyment in Mathematics may subsequently increase their participation in A-level Mathematics (Section 5.1, Figure 14). I therefore recommend the early development of girls' interest, specifically in A-level Mathematics. Activities such as seminars, field trips, computer games and workshops tailored towards developing girls' interest in A-level Mathematics would be of help. More importantly, these activities should involve female role models in Mathematics, including past female students and staff who have enjoyed and succeeded in studying A-level Mathematics.

As observed by Roger, a teacher in this study, the A-level Mathematics curriculum is built on a strong foundation in algebra. Developing students' interest in A-level Mathematics should therefore involve developing students' interest and strong foundation in algebra in the early stages of Mathematics study. For example, Carraher et al. (2006) recommended the introduction of algebra to pupils before the age of eight. I support the view of Carraher et al. that introduction to algebra in the early stages of schooling builds pupils' confidence and interest in Mathematics.

7.7 My personal reflections as a researcher

My study was borne out of my experience as a Mathematics teacher, as somebody who has had the experience of working with an examining body and out of my strong desire to ensure equity in Mathematics achievement and representation by gender at all levels of education. My journey in this research started with the submission of my research proposal. As a person with a mathematics and science background I was wary of moving out of my comfort zone by employing qualitative research methods in this study. This is illustrated by the fact that my initial research proposal was geared towards collecting and analysing quantitative data only. Incorporating qualitative data in my research was therefore a battle for me. Prior to this study I was not very confident in the collection and analysis of qualitative data, but this research has been a great help in developing my skills in this area. However, I remained unsure about the method, even when I started my qualitative analysis, as with my Mathematics background as I was more inclined towards a positivist position. I started to gain confidence as a qualitative researcher after I developed and piloted my questionnaires and interviews. The volume of data produced from qualitative research that I then had to analyse was overwhelming. Gradually a lot of issues concerning the whole research process started becoming clearer, especially during the final stages of my study. It was enlightening to discover what it entailed to analyse and interpret qualitative data and to integrate qualitative and quantitative approaches. There are other forms of data collection such as focus group interviews and classroom observation that I would like to incorporate into future research.

In conclusion, this whole research process has been a very rich experience and has given me a deep insight into research methodology, gender and my own subject of Mathematics. Investigating the factors influencing the choice of mathematics from a gender perspective has been an amazing learning experience for me both as a teacher and as an educational researcher. It is clear that students' academic choices are influenced by a number of factors, including the factors identified in my study. My findings indicate that the issue of underrepresentation of girls in A-level Mathematics needs to be confronted from different angles, including building students' confidence and encouraging more female participation in Mathematics in order to obtain educational equity. This study has made me realise that ensuring equity at all levels of education should be a priority for all stakeholders in education.

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Appendices

Appendix 1: Interview questions for A-level Students

Interview questions for A-level Students

1) What subjects are you offering at A level?
2) What did you take into consideration before choosing/not choosing A level Mathematics?
3) Can you please tell me your experience (likes, dislikes, funs, and influences) in studying Mathematics up to date?
4) Please tell me about some of the people who have had influence on you in Mathematics and how?
5) What is the impact of your family, friends, teachers etc on your decision?
6) Do you have people in your family who are good and enjoy doing Mathematics?
7) Have you had any teacher who has ever made you to like/dislike Mathematics?
8) What is it about this teacher's (personality, approach etc.) teaching that made you to like/dislike Mathematics?
9) Have you had any friend(s) who has/have had impact on your learning of Mathematics? If yes at what stage in your life and how did the person influence your learning?
10) Have you had any perception or belief (religious beliefs, culture, society, racial, ethnic etc) about maths in general and A level Mathematics in particular? If yes have those perception or beliefs change and how?
11) What are your views about maths and gender?
12) Are there things in the classroom that suggest that Mathematics is a subject for all irrespective of gender? Please cite examples
13) In your view do Mathematics teachers' have equal expectations in terms of performance of both sexes?
14) Do your parents (or guidance) have equal expectations for both sexes in terms of performance in Mathematics?
15) Do both sexes receive equal support in the learning of Mathematics from their parents and from their teachers?

16) Are you aware that at GCSE there are no significant differences in the performance of boys and girls and in some cases girls outperform boys in Mathematics?

17) In your view what factors may have contributed to this?

18) Despite these performances, the number of girls who pursue A level Mathematics are less than boys. What do you think are the causes of this trend?

19) What do you think can be done to encourage more girls to pursue A level Mathematics?

Appendix 2: Interview questions for Mathematics Teachers

<u>Interview questions for Mathematics Teachers</u>

1. How many years have you worked as a maths teacher and at what level?
2. Can you share your experience at teaching both A level and GCSE maths
3. Are you able to identify students who receive support from home in the study of Mathematics?
4. What are some of the signs that they do or do not receive support from home?
5. What are the impacts of friends to the learning of Mathematics?
6. What factors do schools consider before allowing students to study A level Mathematics?
7. What factors do your students consider before choosing or otherwise to study A level maths?
8. What influence do teachers have on the selection process?
9. Have identify any perception students have about Mathematics?
10. What are your views on Mathematics and opposite sex?
11. Have you identified any differences in number, performance and the mode of learning of students (by gender).
12. Are you aware that at GCSE there are no significant differences in the performance of boys and girls and in some cases girls outperform boys in Mathematics?
13. In your view what factors may have contributed to this?
14. Despite these performances, the number of girls who pursue A level Mathematics are less than boys. What do you think are the causes of this trend?
15. What do you think can be done to encourage more girls to pursue A level Mathematics?

Appendix 3: Questionnaires Top Set GCSE Mathematics

<u>Top Set GCSE Mathematics</u>

Thank you for agreeing to complete this questionnaire. Please tick the appropriate boxes.

Your answers are voluntary so feel free to miss out questions you are unwilling to answer.

1. Are you Male ☐ Female ☐ ?
2. What is your age?
3. How would you describe your ability in Mathematics?

Very Strong ☐ Strong ☐ Average ☐ Weak ☐ Very Weak ☐

4. Are any of your parents or guardians good at maths? Yes ☐ No ☐
5. How would you describe your parents or guardians level of mathematical achievements?

   Below GCSE ☐ GCSE and no further ☐ A level and no further ☐ A level and beyond ☐

6. How would you describe the level of support you receive from your parents (or guardians) in learning Mathematics?

   High ☐ medium ☐ low ☐ No support ☐

7. Have you ever had a teacher who has made maths enjoyable? Yes ☐ No ☐
8. If yes, what was it about the teacher that made you **like** Mathematics? Please explain

9. Has a maths teacher ever made you to **dislike** Mathematics? Yes ☐ No ☐

10. If yes, what is it about the teacher that made you **dislike** Mathematics?

11. Have you had any friend(s) who has/have had an impact (either negatively or positively) on your learning of Mathematics? Yes ☐ NO ☐

i. If yes, when?

ii. How did the person influence your learning?

12. What are your views about views about Mathematics and gender? Please give as much a detail as possible

13. Are you aware of the benefits of studying Mathematics? Yes ☐
No ☐

Please state your views

14. Do you want to study A level Mathematics? Yes ☐ No ☐

Please state below what is (are) encouraging you or discouraging you from studying A level Mathematics.

15. Are there things in the Mathematics classroom that suggest that Mathematics is a subject for all (or for a particular gender)? Yes ☐
No ☐

Please give examples of things in the Mathematics classroom and say if they encourage or discourage boys or girls from learning maths.

16. In your view do Mathematics teachers' have equal expectations of both sexes in terms of performance in Mathematics? Yes ☐ No ☐

If 'no' which gender do they have higher expectations of and why?
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17. Do your parents (or guardians) have equal expectations for both sexes in Mathematics? Yes ☐ No ☐

If 'no' which gender do they have higher expectations of and why?
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18. Do both sexes receive equal support in the learning of Mathematics from your maths teachers? Yes ☐ No. ☐

If "No", which gender receives more support?
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19. Do you and your siblings of the opposite sex receive equal support from your parents in the learning of Mathematics? Yes ☐ No. ☐

If "No" which gender receives more support?
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20. Recent results and data show that at GCSE there are no significant differences in the performance of boys and girls and in some cases girls outperform boys in Mathematics.

i. In your view what factors may have contributed to this?

ii. Despite these performances, the number of girls who study A level Mathematics are less than boys. What do you think are the causes of this trend?

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21. What do you think can be done to encourage more girls to pursue A level Mathematics?

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22. If Mathematics was not compulsory at GCSE, would you have chosen Mathematics?

Yes ☐ No ☐ I am not too sure ☐

Thank you for taking part and please feel free to offer any further comments in the space below

Appendix 4: Questionnaires A-level Mathematics Students

A-level **Mathematics Students**

Thank you for agreeing to complete this questionnaire. Please tick the appropriate boxes.

Your answers are voluntary so feel free to miss out questions you are unwilling to answer.

1. Are you Male ☐ Female ☐ ?
2. What is your age?
3. What is the name of the 11-16 secondary school you attended? ....
4. Type of school(11-16): Mixed ☐ All- Boys ☐ All-Girls ☐
5. How would you describe your ability in Mathematics?

Very Strong ☐ Strong ☐ Average ☐ Weak ☐ Very Weak ☐

6. Are any of your parents/guardians good at maths? Yes ☐ No ☐
7. How would you describe your parents or guardians level of mathematical achievements?

Below GCSE ☐ GCSE and no further ☐ A-level and no further ☐ A-level and beyond ☐

8. How would you describe the level of support you receive from your parents (or guardians) at learning Mathematics?

High ☐ Medium ☐ Low ☐ No support ☐

9. Please state below what encouraged you to study A level maths (or what you took into consideration before you chose A level maths).

10. Have you ever had a teacher who has made maths enjoyable? Yes ☐
No ☐

11. If yes; what is it about the teacher that made you to **like** Mathematics? Please explain

12. Has a maths teacher ever contributed to you disliking Mathematics?
Yes ☐ No ☐

13. If yes; what is it about the teacher that caused you to **dislike** Mathematics?

14. Have you had any friend(s) who has/have had impact (either negatively or positively) on your learning of Mathematics? Yes ☐ NO ☐

iii. If yes, when?
....
....

iv. How did the person influence your learning?

15. Are you aware of the benefits of Mathematics? Yes ☐ No ☐

Please state your views about the benefits.

16. Would you want to go further with Mathematics after A level? Yes ☐ No ☐

Please state below what is (are) encouraging you or discouraging you from going further with Mathematics.

17. What are your views about Mathematics and gender?

18. Are there things in the Mathematics classroom that suggest that Mathematics is a subject for all (or for a particular gender)? Yes ☐ No ☐

Please give examples of things in the Mathematics classroom and state whether they encourage or discourage boys or girls from learning Mathematics.

19. In your view do Mathematics teachers' have equal expectations of both sexes (male and female)? Yes ☐ No ☐ If 'no' which gender do they have higher expectations of and why?

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20. Do your parents (or guardians) have equal expectations for both sexes in Mathematics?

Yes ☐ No ☐

If 'no' which gender do they have higher expectations of and why?

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21. Do both sexes receive equal support in the learning of Mathematics from your Mathematics teachers? Yes ☐ No. ☐

If "No", which gender receives more support and why?

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22. Do you and your siblings of the opposite sex receive equal support from your parents at the learning of Mathematics? Yes ☐ No. ☐

If "No" which gender receives more support and why?

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23. Recent results and data show that at GCSE there are no significant differences in the performance of boys and girls and in some cases girls outperform boys in Mathematics.

iii. In your view what factors may have contributed to this trend?

iv. Despite these performances the number of girls who study A level Mathematics is less than boys. What do you think are the causes of this trend?

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24. What do you think can be done to encourage more girls to study A level Maths and beyond?

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25. If Mathematics was not compulsory at GCSE, would you have chosen Mathematics at GCSE?

Yes	No	I am not sure
☐	☐	☐

Thank you for taking part and please feel free to offer any further comments in the space below

Appendix 5: Questionnaires A-level Students not studying A-level Mathematics

A-level **Students not studying A-level Mathematics**

This questionnaire is for A level Students who by virtue of their good performance in GCSE Mathematics could have studied A level Mathematics but decided against it

Thank you for agreeing to complete this questionnaire. Please tick the appropriate boxes.

Your answers are voluntary so feel free to miss out questions you are unwilling to answer.

1. Are you Male ☐ Female ☐ ?
2. What is your age?
3. What is the name of the 11-16 secondary school you attended?
   ....
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   ....
4. Type of school (11-16): Mixed ☐ All- Boys ☐ All- Girls ☐
5. How would you describe your ability in Mathematics?

Very Strong ☐ Strong ☐ Average ☐ Weak ☐ Very Weak ☐

6. Are any of your parents /guardians good at maths? Yes ☐ No ☐
7. How would you describe your parents or guardians level of mathematical achievements?

   Below GCSE ☐ GCSE and no further ☐ A level and no further ☐
   A level and beyond ☐

8. How would you describe the level of support you receive from your parents (or guardians) at learning Mathematics?

High	medium	Low	No Support
☐	☐	☐	☐

9. Please state below why you chose **not** to study A level maths (or what discouraged you from doing A level maths).

10. Have you ever had a teacher who has made maths enjoyable? Yes ☐
No ☐

11. If yes; what is it about the teacher that made you to **like** Mathematics? Please explain

12. Has a maths teacher ever contributed to you **disliking** Mathematics?
Yes ☐ No ☐

13. If yes; what is it about the teacher that caused you to **dislike** Mathematics?

14. Have you had any friend(s) who has/have had an impact (either negatively or positively) on your learning of Mathematics? Yes ☐
NO ☐

v. If yes, when?
……..

vi. How did the person influence your learning?

15. Are you aware of the benefits of Mathematics? Yes ☐ No ☐

Please state your views about the benefits.

16. What are your views about Mathematics and gender?

17. Are there things in the Mathematics classroom that suggest that Mathematics is a subject for all (or for a particular gender)? Yes ☐ No ☐

    Please give examples of things in the Mathematics classroom and state whether they encourage or discourage boys or girls from learning Mathematics.

18. In your view do Mathematics teachers have equal expectations of both sexes (male and female)? Yes ☐ No ☐ If 'no' which gender do they have higher expectations of and why?

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19. Do your parents/guardians have equal expectations for both sexes in Mathematics? Yes ☐ No ☐

If 'no' which gender do they have higher expectation and why?
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20. Do both sexes receive equal support in the learning of Mathematics from your maths teachers? Yes ☐ No. ☐

If "No", which gender receives more support?
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21. Do you and your siblings of the opposite sex receive equal support from your parents in the learning of Mathematics? Yes☐ No. ☐

If "No" which gender receives more support and why?
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22. Recent results and data show that at GCSE there are no significant differences in the performance of boys and girls and in some cases girls outperform boys in Mathematics.

v. In your view what factors may have contributed to this?

vi. Despite these performances the number of girls who study A level Mathematics is less than boys. What do you think are the causes of this trend?

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23. What do you think can be done to encourage more girls to pursue A level Mathematics?

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24. If Mathematics was not compulsory at GCSE, would you have chosen Mathematics?

Yes ☐ No ☐ I am not sure ☐

Thank you for taking part and please feel free to offer any further comments in the space below

Appendix 6: Participant Consent Form

Participant Consent Form

Title of Project: **Investigating the factors influencing the choice of Mathematics at A level: A Gender Perspective**

Please initial box to answer with 'yes'.

Name of Researcher:

Name of Participant:

1. I have read and I understand the information letter for the above project and I have had the opportunity to ask questions.
2. I understand that I agreed to have my work/interview analysed and that I can take my agreement back at any time.
3. I understand that my name will not be used and that nobody will know that it is my work/interview that is being analysed.
4. I agree that my work/ interview is being used in the essay/project.

Name of Participant	Date	Signature

Name of person taking consent	Date	Signature

Appendix 7: Project Pupil Information Sheet

Project Pupil Information Sheet

Investigating the factors influencing the choice of Mathematics at a level: A Gender Perspective

You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me or your Mathematics teacher if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

What is the project's purpose?
The proportion of girls pursuing Mathematics A level falls below that of boys (DfES, 2009). This project is an enquiry into the factors that encourage or discourage students from opting to study A level Mathematics at schools, with particular attention to gender.

Aims
To analyse examination entries and performance by gender in GCSE and A level.
To investigate factors influencing the choice of A level Mathematics by students from teachers' and students' perspectives.
To investigate the smaller proportion of females than males opting to study A level Mathematics.
To investigate the causes of this discrepancy from teachers' and students' perspectives

Why have you been chosen?
You have been chosen for this study because you did well in GCSE Mathematics and either:

1) decided to study AS level Mathematics or
2) decided not to study AS level Mathematics

Do you have to take part?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form). You can still withdraw at any time and it won't make any difference to your progress in school. You do not have to give a reason for withdrawing.

What will happen to you if you take part?
You will be asked to take part in a tape recorded interview and/or to complete a questionnaire to find out your views about A level Mathematics.
This interview will last around 25 minutes and I will ask you about your views on reasons affecting your choice of A level subjects, with particular regard to Mathematics. The interview will take place in your school at a convenient time and place for you.

Will you be recorded, and how will the recorded media be used?
The interviews will be recorded on a digital audio recorder. Recordings will be used only for analysis. I will not use them for anything else without your written permission, and no one outside the project will be allowed access to the original recordings. Names and details that would identify you, your teacher or your school will not be revealed in any reports, publications, communications or general conversations. Data will be stored under safe, password protected conditions. At the end of the project, the data will be destroyed.

What are the possible disadvantages and risks of taking part?
There are no possible dangers or risks of taking part. If anything happens that you are not happy about, please let me know straightaway. You can contact me on 0114 2310109 or on edp07so@sheffield.ac.uk.
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What are the possible benefits of taking part?
The possible benefits of taking part are that the project may help you to think about factors influencing your choice of subjects and your views about studying Mathematics.

What happens if the research study stops earlier than expected?
If the study stops earlier than expected, you will be fully informed of the reason.

What if something goes wrong?
If you are unhappy about any part of the project, please contact me straightaway. I will sort out any concerns as soon as possible. You can contact me on 0114 2310109 or on edp07so@sheffield.ac.uk.

Will your taking part in this project be kept confidential?
All the information that will be collected about or from you during the course of the research will be kept strictly confidential. You, your school or teachers will not be identified in any reports or publications. (Please see section “Will you be recorded, and how will the recorded media be used?” above).

What will happen to the results of the research project?
This project is part of my doctoral degree programme at the University Of Sheffield Department Of Educational Studies which I am studying on part-time basis. The results of the research, in the form of the dissertation will be lodged in the University of Sheffield Library.

Who is organising and funding the research?
I am organising and funding the project myself.

Who has ethically reviewed the project?
This research study has been checked according to the University of Sheffield Ethics Review Procedure to make sure the research is safe and will not harm anyone involved.

The contact point if you have any concerns which cannot be addressed by me is:

Dr Chris Winter, Senior Lecturer, University of Sheffield Department of Educational Studies, School of Education, 388 Glossop Road, Sheffield, S10 2JA Tel 0114 2228142
c.winter@sheffield.ac.uk

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking part in the project.

Appendix 8: Project Teacher Information Sheet

Project Teacher Information Sheet

Investigating the factors influencing the choice of Mathematics at A level: A Gender Perspective

You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

What is the project's purpose?

The proportion of girls pursuing Mathematics A level falls below that of boys (DfES, 2009). This project is an enquiry into the factors that encourage or discourage students from opting to study A level Mathematics at schools, with particular attention to gender.

Aims

To analyse examination entries and performance by gender in GCSE and A level.

To investigate factors influencing the choice of A level Mathematics by students from teachers' and students' perspectives.

To investigate the smaller proportion of females than males opting to study A level Mathematics.

To investigate the causes of this discrepancy from teachers' and students' perspectives

Why have you been chosen?

You have been chosen for this study because of you are a Mathematics teacher and have had experience at teaching students at GCSE and/or A level.

Do you have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form) and you can still withdraw at any time without it affecting any benefits that you are entitled to in any way. You do not have to give a reason.

What will happen to you if you take part?

You will be asked to participate in a 45-60 minute interview which will be tape recorded. In the interview I will ask you about your views on reasons affecting students' choice of A level subjects, with particular regard to Mathematics. The interviews will take place in your school at a convenient time and place for you.

I would be grateful if you could let me know the time and date that will be convenient for you to be interviewed. If it is within your jurisdiction I would be very grateful if you would agree to assisting me in organising interviews with 8 A level students; 2 males and 2 females studying AS Mathematics and, 2 males and 2 females who performed well in GCSE Mathematics but decided not to do A level Mathematics.

Will you be recorded, and how will the recorded media be used?
The interviews will be recorded on a digital audio recorder. Recordings of will be used only for analysis. I will not use them for anything else without your written permission, and no one outside the project will be allowed access to the original recordings. Names and details that would identify you or your school will not be revealed in any reports, publications, communications or general conversations. Data will be stored under safe, password protected conditions. At the end of the project, the data will be destroyed.

What are the possible disadvantages and risks of taking part?
There are no possible dangers or risks of taking part. If anything happens that you are not happy about, please let me know straightaway. You can contact me on 0114 2310109 or on edp07so@sheffield.ac.uk.

What are the possible benefits of taking part?
You may find the opportunity to reflect on the possible reasons for students choosing to or not to pursue A level Mathematics to be beneficial in managing your recruitment policy and practice.

What happens if the research study stops earlier than expected?
If the study stops earlier than expected, you will be fully informed of the reason.

What if something goes wrong?
If you are unhappy about any part of the project, please contact me straightaway. I will sort out any concerns as soon as possible. You can contact me on 0114 2310109 or on edp07so@sheffield.ac.uk.

Will your taking part in this project be kept confidential?
All the information that will be collected about or from you during the course of the research will be kept strictly confidential. You, your school or students will not be identified in any reports or publications. (Please see section “Will you be recorded, and how will the recorded media be used?” above).

What will happen to the results of the research project?
This project is part of my doctoral degree programme at the university of Sheffield Department of Educational Studies which I am studying on part-time basis. The results of the research, in the form of the dissertation will be lodged in the University of Sheffield Library.

Who is organising and funding the research?
I am organising and funding the project myself

Who has ethically reviewed the project?

This research study has been checked according to the University of Sheffield Ethics Review Procedure to make sure the research is safe and will not harm anyone involved.

The contact point if you have any concerns which cannot be addressed by me is:

Dr Chris Winter, Senior Lecturer, University of Sheffield Department of Educational Studies, School of Education, 388 Glossop Road, Sheffield, S10 2JA Tel 0114 2228142
c.winter@sheffield.ac.uk

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking part in the project.

Appendix 9: Ethical Review Permission

The University Of Sheffield.	The School Of Education.

Samuel Owusu-Amoah

Head of School
Professor Jackie Marsh

Department of Educational Studies
The Education Building
388 Glossop Road
Sheffield S10 2JA

Telephone: +44 (0114) 222 8096
Fax: +44 (0114) 2228105
Email: jacquie.gillott@sheffield.ac.uk

Dear Samuel

Re: Investigating the Factors Influencing the Choice of Mathematics at A-level: A Gender Perspective

Thank you for your application for ethical review for the above project. The reviewers have now considered this and have agreed that your application be approved with the following optional amendments.

(Please see below reviewers' comments)

Approved with the following suggested, optional amendments (i.e. it is left to the discretion of the applicant whether or not to accept the amendments and, if accepted, the ethics reviewers do not need to see the amendments):
Describe age range of pupils and explain why the consent of their parents or guardians is or is not required in this case.

Yours sincerely

Mrs Jacquie Gillott

Programme Secretary