The Factors Influencing Secondary School Girls’ Mathematics Subject Selections

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Abstract

In Australia, the number of enrolments of secondary school students in advanced Mathematics courses has been declining. This is at a time when mathematical abilities are considered to be a key component in the progressive and contemporary economy with the future prosperity of the nation depending on a significant proportion of the workforce to be educated disciplines including advanced mathematics. High technological skills and productivity are essential in a world that is becoming increasingly dependent on knowledge and innovation. Of particular concern is, while the gap between genders is closing (with the exception of the high performing students); the gender discrepancies in enrolments in some programs are substantial, particularly in the areas of mathematics and engineering. There continues to be an underrepresentation of females in mathematics courses and careers. With consideration of the previous literature, this research study explores the factors that influence girls’ mathematics subject selection in secondary school and discusses the findings and implications. The research was conducted at Hilltop Girls’ College, an all-female secondary school in Melbourne and employed qualitative methods to investigate the experiences and self-perceptions of the participants’ mathematics story together with their ability in mathematics. The data were collected via semi-structured interviews with 22 students from Year 9 to Year 12 and 3 teachers from Hilltop. The analysis of the language used by the girls and teachers in the study revealed the major influence on the students’ subject selection was the perception that mathematics is required as it is a prerequisite for many desirable university courses and it will contribute to increasing the students’ Australian Tertiary Admittance Rank. The students uncovered that studying mathematics is considered valuable primarily because of the understanding that it is important for university entrance, not because it is interesting or required for a career. One of the most interesting findings from this research was that the students had very little idea of how the mathematics they study at school is used in everyday life or in the workforce. The investigation of the culture of mathematics at Hilltop revealed the high status of mathematics at the College which can cause some students to experience anxiety about mathematics and the assessment of mathematics. The other factors that proved to be lesser influences on girls’ choice of mathematics subjects include, gender stereotype, pedagogy, parental influence, the value the girls’ placed on mathematics and the girls’ attitudes towards mathematics.
Declaration

This is to certify that:

i. the thesis comprises only my original work towards the masters except where indicated in the Preface,

ii. due acknowledgement has been made in the text to all other material used,

iii. the thesis is less than 40,000 words in length, exclusive of tables, maps, bibliographies and appendices

__________________________________________________
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Chapter 1 Introduction

Important Choices

Adolescence can be a challenging time for many people. It is a time of exploration and formation of identity; as learners, within the family, within friendship groups and in society in general. It is when values become established and images of possible selves are created (Harter, 1999). The identity within the context of a vocation becomes particularly important at this time, as young people are often faced with making difficult decisions about education, career and life (Eccles, 1994). In many cases, it can start as early as Year Eight when students need to choose elective subjects for Year Nine.

This process can become stressful and onerous for some students, particularly in regards to the selection of mathematics courses.

In Australia, the enrolment in Mathematics courses has revealed a worrying trend: lower standards and lower enrolments. While the proportion of students studying some Mathematics in Year Twelve has remained consistent for some time at a rate of about 80%, the proportion of students studying advanced mathematics in 2011 dropped below 10% for the first time since Australian Mathematical Sciences Institute (AMSI) began recording student numbers. While the number of intermediate students also declined from 19.9% in 2010 to 19.8% in 2011, the proportion of elementary mathematics students increased (AMSI, 2012).

Importance of Mathematics

The Organisation of Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) results for 2012 indicated that out of the 65 participating countries and economies, Australia had the 19th highest Mathematics mean score. While Australia is still above the average, this is of concern as Australia’s performance has deteriorated since 2003 (OECD, 2012). This is a worrying trend particularly in light of the following statement in the OECD results analysis document:

Proficiency in mathematics is a strong predictor of positive outcomes for young adults, influencing their ability to

As stated in the Office of the Chief Scientist report to the Prime Minister regarding Mathematics, Engineering and Science in the National Interest in May 2012, the future prosperity of the nation depends on a significant proportion of the workforce to be educated in these disciplines. High technological and productivity are essential to the growth of a contemporary and progressive economy as the world continues to be dependent on knowledge and innovation. The report states that Australia’s economic future is not in low-end manufacturing or lower wage rates. This is highlighted by the recent closures of the car manufacturing companies Holden in Adelaide and Ford in Geelong. These were both iconic Australian companies, however, with the evolving economy; they will no longer exist after 2017 in Australia. Industries lacking in science and mathematical literacy and that are low in technical skills will not be able to compete with other leading economies that have the ability to innovate and adapt to a higher knowledge base (Chief Scientist, 2012).

There is a shortage of high quality talent in mathematical sciences. Despite the desirability of mathematically educated and qualified people in the workforce, university enrolments have shown a decline in the number of students showing interest in mathematics and science areas (Chief Scientist, 2012). The number of students graduating from mathematical university degrees in Australia is low, particularly in relation to other countries, such as China and Korea (OECD, 2012). The ratio of mathematical sciences to non-mathematical science degrees in Australian in 2010 was 18.8 per cent, which is a drop from 2002 when the ratio was 22.2 per cent (Chief Scientist, 2012). Some possible explanations for this include; many students find mathematics too difficult, mathematics teaching can often be old-fashioned and does not spark the intellectual passions of students, or the institutions and policies established by various levels of government do not create incentives for students to engage and participate in mathematics.

This is particularly challenging for Australia because at the time of subject selection. Students appear to put a greater emphasis in their decision-making on their perceptions of desirable careers and university entrance requirements rather than of their perceptions of the educational
experience itself (Walkington, 1998). Despite the crucial requirement of mathematical sciences for the growth of the economy and for the changing workforce, the perception of many young people is that mathematics is not related to real life, it is boring, or high-level mathematics is not used in many professions (Chief Scientist, 2012, AMSI, 2006).

One industry that needs mathematically able graduates with very strong mathematical abilities, innovation and creative thinking is engineering. Student enrolments in engineering are of particular concern. Ms Kate Hurford, the Associate Director of Public Policy for Engineering Australia, presenting at the National Strategic Review of Mathematical Sciences Research in Australia in 2007 suggested the key issue for engineering in Australia is the low rate of graduation and the low number of students with the ability and interest entering engineering courses. These courses are particularly important nationally, as they are vital to productivity growth and higher living standards for all Australians (Chief Scientist, 2012). However, due to the low demand, universities are finding it increasingly difficult to support such subjects in the commercial environment in which they now find themselves.

Contrary to students’ perceptions, Hurford (2006) suggests that Australia needs more students to study high level school mathematics science and technology subjects and who take this knowledge and continue into tertiary education in engineering.

Major companies have made significant “knowledge-based” investments in Australia in the area of mathematical sciences. American pharmaceutical company Eli Lilly also has their Clinical Outcomes Research Institute in Sydney. Last year, the company spent $5.3 billion on their research and development divisions. That is equivalent to $20 million per working day. They employ over 7700 employees in this Australian Research and Development division which is 20% of their workforce. Career opportunities in this division of the company include Environmental Engineering, Facilities Design and Construction Engineering, Packaging Engineering, Plant Engineering, Process Automation/Software Engineering, Process Development Engineering, Process Engineering, Technical Services as well as positions in finance, business divisions and manufacturing. The Eli Lilly website states they are looking for people with degrees in
chemistry, biochemistry, pharmacy, microbiology, engineering or a related science, all of which require advanced mathematics to enter and complete the degree (Eli Lilly, 2013).

Roche, one of the world's leading research-based healthcare companies and is known for many innovative contributions to medicine. Roche has a Biometrics Department in Australia whose mission is to ‘develop analytical strategy and qualitative evidence needed to inform decisions and answer critical questions about therapeutic benefit and risk of our molecules to our patients’ (Roche, 2103). The career opportunities include statistical scientist, process analyst, data manager and software developer. These all require very high mathematical ability and training.

Pfizer Australia, a subsidiary of Pfizer Inc. and Australia’s leading provider of prescription medicines and clinical health products, provides career opportunities in finance, strategic planning, research and development and engineering, all of which require advanced mathematical thinking and skills. Pfizer located its Asia/Africa Regional Biometrics Centre in Sydney, and has invested a significant amount of money to the centre. It also offers many opportunities for employment hiring over 1600 people across all the locations in Australia. Pfizer is strongly committed to Research and Development investment and, globally, expects to spend around US$6.5 billion on R&D activities in 2013 (Pfizer, 2013).

Ian Marschner, the Director of Biometrics for Pfizer Australia, suggests mathematical thinking in some form will be a key component of virtually any industry research & development process. When inspecting websites and advertisements of employment opportunities in these companies, the essential criterion that is listed includes: critical thinking, inventiveness, being a creative innovator, being a innovating thinker, processing analytical skills, have an ability in decision-making and problem solving.
**Worldwide Business Development & Innovation**

Pfizer’s Worldwide Business Development and Innovation (WBDI) team is central to shaping Pfizer’s future through our mission to intelligently drive Pfizer’s growth objective in novel ways that will deliver greater value for our patients, customers and shareholders.

Our Business Development team is focused on acquiring assets, which further strengthen our core while maximizing the value of non-core assets outside the company. Our Innovation team is developing and refining models for adjacent business opportunities while building a platform of innovation, allowing each member of our organization to collaborate and think innovatively.

We are looking for intellectually-driven people who share our values to join our science and clinical team. You will be a creative innovator and thinker whose research can improve the lives of millions. Using our industry-leading facilities to conduct groundbreaking research, you could work on:

- Inventions and patents
- Syntheses or biological evaluation of compounds leading to drug candidates
- Target selection/identification and validation
- Out-licensing compounds
- Leveraging technologies
- Regulatory submissions
- Design and execution of clinical trial protocols
- Disclosure of clinical data
- Development and support of efficient manufacturing processes and technologies

**Core Finance**

Executes core finance activities on behalf of the corporation and demonstrates influence and leadership

**Skill Focus**

- Accounting (Deep)
- Processes and Controls
- Role/Area-specific skills
- Knowledge of the business
- Critical thinking

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**Figure 1 Job Advertisement for Pfizer Australia** (Pfizer, 2013)
Gender and Mathematics

When considering the enrolments in mathematics in secondary school, it is sensible to examine the difference between males and females. The gender discrepancies in enrolments in some programs are substantial, particularly in the areas of mathematics and engineering (Chief Scientist, 2012) and there continues to be an underrepresentation of females in mathematics courses and careers (Helme & Teese, 2011). While there used to be a presumption that it was biological factors that made males possess superior mathematical ability, contemporary research refutes these claims for male dominance (Brown and Joseph, 1999, Eccles and Jacobs, 1986, Geist and King, 2008, Spenser, Steele and Quinn, 1999).
The 2012 PISA results indicate that males outperform females in 38 out of the 65 participating countries and economies in mathematics while females outperformed males in 5 countries. A worrying statistic in Australia, however, is high performing males (those who achieved the highest level of five or six) are well ahead of high performing females in mathematics (OECD, 2012). Seventeen percent of males who achieved this level compare with 12.5% of females.

While, longitudinally, the PISA results indicate that the gap between genders is closing (with the exception of the high performing students), the literature does offer suggestions as to why females are still not participating in mathematics courses at the same rate as males in upper secondary school or at tertiary level. There have been suggestions that the difference in males and female enrolments is essentially to do with the socialization of females in relation to mathematics. The PISA results suggest the gender gap in mathematical ability varies considerably across countries, suggesting mathematics ability is not inherent, but acquired, formed and shaped by social reinforcement (OECD, 2012). This can lead to mathematics seen as a masculine sphere causing some females to find it difficult to associate themselves with mathematical domains. Earlier reports suggest that this is linked to females not having interest in the mathematical science disciplines, preferring the humanities and social sciences (Campbell and Beaudry, 1998, Eccles et al., 1990, Updegraff and Eccles, 1996).

As a consequence, universities and industry are creating incentives for females to enter into the mathematical sciences. These include the offer of scholarships to The University of Melbourne in engineering to high achieving students from under-represented groups including women, financially disadvantaged students, rural or isolated students, students with disability or medical conditions and Indigenous Australians. The Defence Science and Technology Organisation (DSTO), a division of the Department of Defence, is the agency that implements science and technology to protect and defend Australia. The DSTO has started a scholarship program specifically for female students to fulfil the obligations of their 2013 – 2018 strategic plan. One of the key strategies in the plan is to enhance engagement with universities and improve the DSTO’s gender and race diversity. It is designed to address the disproportionate low number of
females in the science and engineering fields by offering the undergraduate scholarship (DTSO, 2013).

Other issues cited in literature that have been suggested as reasons why there is a difference in the enrolments of males and females in mathematics subjects at secondary school include: the difference in anxiety levels between males and females caused by the study of mathematics, the impact of social comparison on subject selection, the impact of self-efficacy and confidence on subject selection and the perception that the higher level mathematics studied at school (Mathematical Methods and Specialist Mathematics, see Appendix C) has no real life uses. All these factors will be elaborated on in the review of the literature in Chapter two.

The difference in enrolments and participation in mathematical courses and careers of males and females is of particular concern because of the circumscription of career options due to mathematics avoidance that has been seen, and is detrimental to women’s career development (Chief Scientist, 2012, Lent Lopez and Bieschke, 1993). This is a major incentive to continue to explore the factors that influence females to choose higher mathematics.

There is a political, social and economic imperative in Australia that there must be a significant part of the workforce educated in mathematics and sciences in order to develop the high technology, high productivity economy required for prosperity in the future. However, as previously stated, there is a declining interest in advanced mathematics courses at Year twelve and an underrepresentation of females in advanced mathematics courses at school and university. This also provides motivation to build on the research into females’ mathematics course enrolments.
Therefore, to continue in this exploration, the first research question for this study is:

**What are the factors that influence secondary school girls’ mathematics subject selection?**

The research will be conducted at Hilltop Girls College, an all-female secondary school in Melbourne. The data will be collected via semi-structured interviews with 22 Year nine, ten, eleven and twelve students to explore the factors that influence their choice to continue or not to continue studying mathematics into senior school. Semi-structured interviews will also be conducted with three teachers from the College to capture the culture of mathematics at the College.

The second research question for this study is:

**How does the mathematics culture of the school influence these selections?**

In order to address this question, qualitative methods will be employed. By investigating adolescent females’ attitudes and self-perceptions of mathematics and their ability in mathematics, meaning can be made through their words and their existence within the context of the school they attend (Hughes, 2010).

Associations between the culture and attitudes of the College community, and the attitudes of particular students will be examined. The data will explain the different ways the girls of Hilltop College see themselves as learners. This thesis uses their experiences of mathematics education, the language they use to establish their attitudes around mathematics and what the consequences of these attitudes are for their selection of mathematics courses in upper secondary school.

Exploring the meanings and significance of the girls’ factors influencing course selection through the common experiences and language they use will aid understanding of the trends for the girls at this particular school (Elliot, 2010). The research is focused on the discourses and culture of the school and how these have contributed to the attitudes and experiences of
the students preparing to select mathematics courses for later secondary school. The aim of this study is to investigate the factors that influence secondary school girls’ mathematics subject selection.

The Background: Literature and Study Context chapter (Chapter two) examines the literature on the factors influencing subject selections of students in secondary school and provides details of the context of this study. Some of the factors found in the literature include gender differences in mathematics performance, achievement and attitudes, and the stereotypes of gender and subject choices, attitudes and beliefs, interest and mathematics anxiety. The Research Design chapter (Chapter three) discusses the methodology of the research and builds on the research and develops a method to investigate the attitudes and beliefs in a particular school. It develops an idea of the culture of attitudes in the school and then focuses on individual cases. The Results with Links to Literature chapter (Chapter four) describes the findings from the interviews providing interesting responses and insights into the girls’ attitudes towards mathematics and the influence of their selections. The Analysis chapter (Chapter five) evaluates and analyses the findings from the interviews with the girls and teachers and the discussion links back to the previous literature. The Conclusion chapter (Chapter six) discusses the implications for Hilltop College in which the research was conducted.

The number of female students enrolling in advanced mathematics course is declining at a time when mathematical abilities are considered to be a key component in the progressive and contemporary economy. With consideration of the previous literature, this research explores the factors that influence girls’ mathematics subject selection in secondary school and discusses the findings and implications for Hilltop Girls’ College.
Chapter 2 Background: Literature and Study Context

In this chapter, a detailed review of the literature encompassing the factors that influence girls’ selection of mathematical subjects at secondary school is conducted with the intention of using the findings as a guide for the design and methodology of this research study. The previous research and findings revealed by the literature of the main factors of the subject selection of mathematics subjects are examined and discussed. These include mathematics stereotyping, mathematics attitudes and self-efficacy, the anxiety caused by mathematics and other gender factors such as social-economic status and educational aspirations.

Literature

Female participation in mathematics at school level, university level and in careers have been an area of interest and concern for many years. In 1980, Benbow and Stanley’s USA study, using the College Board's Scholastic Aptitude Test for Mathematics (SAT-M), sampled gifted seventh and eighth grade students. The study found that males performed better than females on average. Benbow and Stanley (1980) concluded from these results that ‘superior male mathematical ability’ was the reason for males’ higher mathematical achievement and more positive attitudes towards mathematics. They based this on the assumptions that the group of students participating in the study had exactly the same prior exposure to mathematics in primary school.

Benbow and Stanley’s study contributed to the ongoing debate about the possible causes of the apparent difference between males and females mathematical ability and interest. In 1986, Eccles and Jacobs refuted the conclusions of this study drawing attention to the many absent considerations and instead suggesting that the gender differences in performance and attitude are caused by the differences in social and attitudinal factors. In their two year study of 250 students from Years seven to nine, their teachers and parents, questionnaires were used to gather data along with course results and results from a standardized test. From this, they discovered a difference in the level of mathematics anxiety experienced by female and male students, gender stereotype beliefs and the value attached to mathematics. These factors directly influenced performance and subject selection.
As mentioned in the previous chapter, these gender differences still exist today. There is a belief that males continue to outperform females in mathematics and there is still a shortage of females in mathematical and scientific careers. Many studies researching this phenomenon complement Eccles and Jacobs (1986) theory and suggest there are many cultural forces that have attributed to these differences including social and environmental factors. The purpose of this study is to continue this investigation into the factors suggested by the literature that influence females to continue or discontinue studying mathematics in secondary school.

A literature review informed the choice of method for this study. In the sections that follow, other studies have been organised according to the factors that have been presented in the literature as influences on mathematics subject selection. These factors include gender and stereotype, attitudes and self-efficacy, mathematics anxiety and other gender factors.

**Difference in gender and stereotype, the ‘maleness’ of mathematics.**

There is a perception in society that mathematics is a ‘male domain’; that males perform better than females in all areas of mathematics. The fact that males are more likely to pursue careers which require mathematical skills or have interests in mathematical areas perpetuates the understanding that mathematics is masculine and neither accessible nor desirable for females. This is shown in Burton (1999) who suggest that while there was no gender difference in the way mathematics was understood and practiced; there was a gender difference in career expectations. If the mathematics results from 2013 VCE results are used as a guide, males and females achieved similar results across all three mathematics subjects, with the exception of students that achieved A+ for coursework and examinations where males do continue to outperform females (Victorian Curriculum and Assessment Authority, 2013). This suggests that performance and ability are indeed equal indicating other forces at work influencing females to turn away from studying mathematics and pursuing mathematical careers.

From the literature summarized below, it seems that belief in this gender bias still exists. Jones and Smart (1995) and Mendick (2005) suggest that females are opting out of mathematics as they view the subject as masculine. Hyde, Fennema, Ryan, Frost and Hopp (1990), however, found
from an extensive meta-analysis that it was in fact males that had much stronger stereotyped attitudes than females and that this may be due to the lack of females in advanced mathematics classes and mathematical careers. Hyde et al. (1990) suggests that this stereotyping may be considered a critical factor in deterring females from pursuing mathematics courses or careers. This view may encourage male peers of female students to subtly indicate that females who are successful in mathematics are somehow less feminine. This view contributes to the perceptual defeminisation of mathematics, resulting in disinterest and distance from the study. Walden and Walkerdine (1985) agree arguing that girls who display the ‘masculine’ qualities of hard work, perseverance and carefulness are judged or perceived to be judged as unfeminine.

Mendick (2005) elaborates on this belief suggesting that there are gendered discourses of rationality, genius and popular cultures’ stereotypes. She concluded that it is the socio-cultured context that is the central feature of many young peoples’ relationship with mathematics.

“The dominant discourse around mathematics in popular culture depicts these people as brainy, obsessed with the irrelevant, socially incompetent, male and unsuccessfully heterosexual” (Mendick, 2005).

She found that students see ‘real mathematics’ as different from other subjects and ‘real mathematicians’ as different from ‘real’ or ordinary people. She suggests these discourses are oppositional and gendered. Therefore students inscribe mathematics as masculine so it is more difficult for females to feel talented and comfortable with mathematics (Mendick, 2005).

Wertheim (1997) agrees suggesting mathematical geniuses shown in films and on television are nearly always male and somehow disconnected from reality. She suggests that this negative view of mathematics discourage students, specifically females, from pursuing studying mathematics. A contemporary example of this is the main character of the comedy series ‘The Big Bang Theory’. Dr Sheldon Cooper, a theoretical physicist, reportedly has an IQ of 187. The perception is this character lacks empathy, has difficulty understanding social norms and is unable to recognize sarcasm. While Sheldon seems to be admired for his mathematical and scientific brilliance, he is often described as ‘crazy’ in the
show. Sheldon and the other characters of the show, three other brilliant scientists, support Wertheim’s view when she suggested ‘the media shows mathematical geniuses to be detached from the real world and nearly always male’. I believe that the premise of the show is that these geniuses are socially awkward and have what can be viewed as ‘geeky’ interests including comic books, Star Trek, board games and viewing the heavens from the top of their apartment building.

The character Dr Amy Farrah Fowler was introduced as a partner for Sheldon. She is also a brilliant scientist; however, she seems to be portrayed as dowdy, lacking in fashion sense, inflexible, unsuccessfully heterosexual and also socially unacceptable for a female. This supports Damarin (2000) suggesting those who excel in mathematics at school or indeed say they enjoy mathematics are considered to be ‘nerdy’ or ‘geeky’. She suggests that these students belong to a double ‘marked category’. Females find it difficult to be identified as ‘good at mathematics’ in today’s popular culture, because it is considered masculine and it is geeky. There is a stigma associated with being able at mathematics. Therefore, females may not wish to be deemed a ‘mathematics genius’ given the male stereotype associated with mathematics.

Females may not be seen as ‘mathematically able’ by others in society. Sukhnandan (1999) suggested that this belief begins in the school environment as the teacher’s beliefs and expectations impact on students’ attitudes and perceptions of mathematics. Elwood (2005) found, after interviewing mathematics teachers, that teachers often ascribe mathematics success of males to ability and females’ success to hard work. Leder (1993) agrees finding that males are more likely to attribute their own success to ability while females are more likely to attribute their own lack of success to their lack of ability or task difficulty. Cohen (2005) agrees finding that males success comes from within, talent or natural ability, while females’ success is attributed to external forces; teaching methods, teachers or particular conditions. Boaler (1997, 2002) also found that the attitudes and performance can be affected differently on males and females by particular teaching approaches. These gendered interactions can impact females’ desire to continue to pursue mathematics. After research into the culture of mathematics and examining the norms and behaviours of teachers and students in mathematics classrooms, Barnes (2000), Chapman (2001),
Forgasz (1998), Vale (2003) and Walkerdine (1990) found that males were advantaged and females disadvantaged in the classroom.

Studies that looked closer into classrooms found that teachers interacted differently with males and females (Jungwirth, 1991, Leder, 1993). They found that females were excluded from learning opportunities due to teachers spending more time with males and asking males harder, higher order questions.

On the other hand, in her paper explaining secondary students’ construction of gender, school subjects and subject ability, Frances (2000) found there is a blurring of the traditional dichotomy that students perceived males and females to have equal ability. Many of the responses of the students referred to discourses of individuality to argue that ability is related to the individual, rather than to gender. Brinkworth (1999) agrees finding that mathematical ability is not gender-linked. This study found that mathematics was not stereotyped nor was there any evidence of stigmatism of a student who chose to study the subject. Females thought it was less conventional to study mathematics; however, this did not extent to the negative by the participants of the survey. Leder and Forgasz (2000) after surveying a large number of students from Year seven to ten also found that most students did not stereotype mathematics as a masculine subject. Other studies suggest there has been a change in beliefs away from mathematics as a ‘male domain’ (Watt, 2000), however, Forgasz (2002) found that teachers still asked males more questions and it was more important for males to be good at mathematics for their future, but not as important for females.

Attitude and self-efficacy.

From the literature examined, there appear to be many definitions and explanations of the concept of attitudes. An attitude is typically defined as ‘an affective evaluation indicating favour or disfavour toward an entity’ (Eagly and Chaiken, 1993). For this study, this definition of attitudes has been elaborated to include a series of beliefs and emotional inclinations related to mathematics. This includes: expectations, interest in mathematics, value placed on mathematics and confidence. Self-efficacy, which can be defined as belief in one’s performance capabilities, will also be considered in this section.
There has long been a belief that gender differences exist in affect and attitudes towards mathematics. Fennema and Sherman (1977) lead the way with research into attitudes finding many attitudinal differences between males and females seemingly related to socio-cultural factors. In 1988, Wigfield and Meece in a longitudinal investigation including 564 Year six to Year twelve students found that females reported stronger negative reactions to mathematics than males. Hyde et al. (1990) in the meta-analysis of gender differences in attitudes and affect in mathematics found that it was normal for females to hold more negative attitudes toward the subject. An explanation of what causes such negative attitudes was explored in Gunderson, Ramirez, Levine and Beilock (2012). There is a suggestion that the transmission from adults to children of attitudes towards mathematics happens from parents and teachers via three mechanisms; direct teaching, treatment of males and females and modelling (Gunderson et al., 2012).

Negative attitudes towards mathematics are identified in the literature as a primary factor that influences females’ section of mathematics subjects. Lent, Lopez and Bieschke (1991) explained:

“The relations among self-efficacy, outcome expectations, interest in mathematics courses impacted in the choice of mathematics courses. It was found the self-efficacy information was predictive of and explained gender differences in mathematics self-efficacy and course selection.” (Lent et al. 1991)

Thorndike-Christ (1991) also supported this finding in the study of public middle and senior secondary students. It was stated that attitudes towards mathematics were predictive of intentions to continue to study mathematics. However, this study found female attitudes were more positive than they anticipated from previous research. It was espoused that lack of confidence and lack of interest in mathematics-related careers still existed as a difference between males and females.

Negative attitudes towards mathematics can be traced back to the classroom environment with Forgasz and Leder (1996) in their study of mathematics classrooms, gender and affect found that personalisation in the
classroom is more critical for females than it is for males impacting on interest, confidence and subject selection.

Female perceptions of their abilities, their interest and like of the subject was also found to be a factor in determining females mathematics subject selection by Walkington (1998) in the Australian study in the last two years of secondary school. Crombie et al. (2005) also observed that a direct path from competence beliefs to subject selection in the study of 600 Year nine students. This is significant as the study also established that females had lower self-efficacy than males. Lent et al. (1991) found the self-efficacy information was predictive of and explained gender differences in mathematics course selection.

Some of the literature, including Eccles and Jacobs (1986), suggests that the value females place on studying mathematics and its usefulness is a predictor of subject selection. Meece, Wigfield and Eccles (1990) in a longitudinal study found after sampling 250 Year seven to nine students that value perceptions predicted course enrolments. It was established that there was a link between value perceptions and subsequent performance and then to enrolment patterns. Interestingly, this study found similar patterns of subject selection between males and females. Walkington (1998) supports this finding stating that females were selecting mathematics subjects with more of a focus on perception of careers and the value than perceptions of the educational experience itself. This suggests that females’ rejection of mathematics has little to do with the female herself and more to do with the school system. If the mathematics makes little sense to them and they do not see a use for it in the real world, then females will be dissatisfied and excluded themselves from the subject (Boaler, 1997).

However, in 2005, Crombie et al., in the previously mentioned study, found that the path from value of the subject to enrolment intentions was stronger in males than females. Brinkworth (1999) agrees with males rating the need to study mathematics as a reason for further study higher than females.

The literature suggests confidence as a sub-set of attitudes is considered a factor that can influence females’ subject selection. While Thorndike-Christ (1991) found, as mentioned earlier in the chapter, that
female attitudes were more positive than previous research suggested, females continued to display a lack of confidence in their ability to learn mathematics compared to males. Hyde et al. (1990), however, suggested that the difference in confidence levels of males and females displayed increased as the students moved from middle to senior secondary school, with females becoming less confident in their mathematical abilities as they matured.

Jones et al. (1995) discussed in detail confidence as a key factor of difference in enrolment of males and females in mathematics subjects. This in depth exploration of the research conducted in mathematics confidence discusses the social aspect of ‘being good at mathematics’. This strongly supports Damarin (2000) and Mendick (2005) findings as discussed earlier in the chapter. It continues the discussion to suggest females show less confidence in working with context problems and that teacher’s styles and attitudes have more of an impact on females’ confidence in mathematics than males. While Boaler (1994) agrees suggesting females do not like working with ‘pseudo-real’ contexts, Leder (2001) found females did better when solving these types of questions.

**Mathematics related anxiety.**

Another major factor that may influence females’ selection of mathematics subjects from the literature is the anxiety that mathematics has been shown to cause. For this study, mathematics anxiety is defined as the fear and uneasiness felt when performing mathematics. This causes tension and even a sense of dread when asked to complete mathematics, even in everyday life. There has been a great deal of evidence in the literature that suggests this anxiety can cause poor mathematics competence due to its impact on the student’s working memory and the ability to acquire the core mathematics and number concepts (Beilock, 2008, Hembree, 1990, Lyons and Beilock. 2012, Matterella-Micke, Mateo, Kozak, Foster and Beilock 2011, Miller and Bichsel, 2004, Wigfield and Meece, 1988).

As early as 1986, Eccles and Jacobs identified there was a difference in mathematics anxiety between males and females. This view has continued to be evident in the literature. In the meta-analysis conducted by Hembree (1990) the results of 151 studies were analysed. This showed
females to display higher levels of mathematics anxiety than males. Thorndike-Christ (1991) suggested the lack of confidence (as mentioned earlier) and mathematics anxiety coupled with a lack of interest in mathematics related careers were the main factors influencing females’ subject selections.

Some investigations explored in more depth the reasons why females seem to suffer mathematics anxiety more than males. Steele and Arths (1998) suggest that the traditional pedagogies of mathematics, which has a focus on pen and paper drill and consistent testing for correct responses, is a major cause of mathematics anxiety, particularly in females. In contrast to the development of contemporary pedagogy employed in many studies, the explain-practice-memorise teaching approaches often realised in mathematics classes does not develop the critical thinker and hence limits the number of mathematics subjects selected.

Chapman (2001) in a discussion about constructing masculinity in school mathematics suggests that dialogue commonly used in traditional classrooms advantages dominant males and therefore they are less likely to experience mathematics anxiety.

Dwerk (1986) in a study of the motivational processes that affect learning suggest that females have maladaptive motivational patterns that are inherent characteristics are incongruent with the traditional teaching pedagogies of mathematics. She suggests behaviours such as avoiding high-risk learning situations, a preference for an environment that one is certain to succeed and situations that lead to correct answers rather than challengers and a provision for opportunities to learn all lead to females being unproductive and uncomfortable. Boaler (2002) disagrees stating that these behaviours should be considered highly adaptive as the females are in an environment where correct answers, fast work and low-risk traditional pedagogy are valued.

Test anxiety, a subset of mathematics anxiety, may be exacerbated in mathematics due to the number of tests taken in the subject. Felson and Trudeau (1991) found that females anxiety displayed reflects test anxiety more than a fear of mathematics. Boekarts and Segal (1996) found that males experience learnings with a test in a more positive way than females.
Furthermore, Brown and Josephs (1999) closely examined stereotype relevance and gender difference in mathematical performance in tests and other assessment. This study showed that males and females have different concerns when taking standardised tests and when these concerns are made relevant, that is, the reason for the taking the test becomes known, (the test was designed to show the student to be exceptionally weak or strong), performance was shown to suffer.

While much of the literature attributes the higher level of mathematic anxiety of females to social factor and stereotypes, Fennema and Tartre (1985) identified a gender difference in spatial visualisation and these differences are still apparent in more recent studies. Maloney, Waechter, Risko and Fugelsang (2012) provide evidence that mathematics anxiety in females is caused by inferior ability of spatial processing compared to males. Spatial processing ability refers to the skill in representing and transforming symbolic, non-linguistic information (Gardner, 1983). Two studies of 118 undergraduates and 249 adults who participated in online questionnaires showed results revealing the relationship between gender and mathematics anxiety is predicted by spatial processing ability. They concluded that females may be more anxious about mathematics because they are not as good as males at spatial processing, explaining why females many not choose to continue to study mathematics subjects at secondary school and university. Casey, Nutall and Pezaris, (2001) agree with their study finding by Year eight, females’ relatively inferior spatial-mechanical ability contribute to lower scores on the types of mathematics at which males generally excel. Fennema and Tartre (1995), however, in a later study examining selected cognitive and affective variable to mathematics achievement found no consistent sign of gender difference for spatial skills. They suggest a re-evaluation of the thinking that boys’ success in mathematics is helped by their ability in spatial skills.

In a complex study of anxiety, working memory, gender and mathematics performance, Miller and Bischel (2004) concluded that gender was not correlated with mathematics performance, it was correlated with mathematics anxiety, reporting females had higher mathematics anxiety levels. As mentioned earlier, working memory has been found to be strongly related mathematics performance. While much of the previous research in this area suggests a disruption to verbal working memory due to anxiety
(Miller and Bichsel, 2004), this study found mathematics anxiety had a significant inverse relationship with the visual memory measure. This is significant due to the large proportion of mathematics within this realm. Mathematics anxiety was the most significant factor in predicting variance in both applied and basic mathematics performance. Mathematics anxiety did significantly account for the variance in applied mathematics performance in females, and therefore the implication that this impacts females’ enrolments in mathematics courses. Forster and Mueller, (2001) agree as their study of Year twelves using a graphics calculator to answer different types of questions found that males out-performed females in the graphical interpretation questions while females performed better in the algebra-based questions. This suggests that males perform better on short-answer questions while females perform better on the problem solving questions (Leder, 2001).

Lyons and Beilock (2012) suggest that these findings infer that effective educational interventions to uncover mathematically competent individuals who would usually not be identified, may need to be focussed on controlling negative emotional corollaries to mathematics instead of additional superfluous mathematics practice.

Other gender differences.

As mentioned above, there has been a long standing belief that males were biologically superior to females at mathematics. The literature examined offered other explanations in addition to this assumption that may influence females’ mathematics subject selections.

Brinkworth (1999) explored gender differences in a study that collected data from Year twelve students from ten different types of schools in South Australia. The survey asked 392 students about their current study of mathematics, achievement level and expectations for the future work and future study. The students were also asked to give their opinion about varies aspects of mathematics. The results indicated that, while enrolment patterns were in line with typical Australian Year twelve enrolments, there was a reduction in gender differences in beliefs about mathematics. Where there were differences, it was generally about mathematical careers and the people that work in these fields.
Other explanations include socioeconomic status, mathematics education and educational aspirations. In the study conducted in 2003, Reynolds and Conway looked at identifying factors that would explain the differential mathematics participation among females in secondary school. This study found the higher the socioeconomic status of females and the educational level of the female’s mother, the more likely they were to enrol in advanced mathematics courses in secondary school. Interestingly, this study also found that the higher the educational aspiration of the female (university or post-graduate studies), the more likely they were to enrol in advanced mathematics courses, and, if the further study was to be in a non-traditional female mathematical sciences career area, females would be three times more likely to enrol in advanced mathematics courses in secondary school.

Atweh and Cooper (1995) in an Australian study observed two female-only classrooms of different socioeconomic status. They found that the higher the socioeconomic background constructed mathematics that was perceived as required for into higher education while the lower socioeconomic background students constructed mathematics needed for everyday life. Teese (2000) agrees arguing that students from higher socioeconomic backgrounds select their subjects to improve tertiary entrance scores. Lamb (1996) concurs finding after investigating four high schools in Australia, it depends on the females socioeconomic background and school policies that impact on females’ participation in advanced mathematics subjects.

Van Langen, Rekers-Mombarg and Dekkers (2008) agrees citing parental level of education as a measure of socioeconomic status and ethnic background as influences of the subject selections of mathematics subjects of females but not males. It was suggested that this may be due to any weakness in mathematics shown by girls is hastily interpreted in a stereotypical manner reinforcing the gender-role viewpoints. Moreover, the findings suggested that females who chose subjects due to extrinsic motives were more likely to choose mathematics subjects than females who chose subjects due to intrinsic motives.

There is a suggestion that males and females learn and process mathematics differently and that this difference is not taken into account by
education systems. Geist and King (2008) suggest after a review of assessment data, literature and research on gender differences in mathematics, individualising the approach to teaching males and females, both sexes’ needs can be met. Cohen (2005) also agrees that females learn mathematics differently to males. This study found that when females have an opportunity to learn mathematics in a classroom with only other females, it changes the females’ engagement in learning, overall participation and there is a chance to diminish or completely restrict the stereotyped messages that mathematics is a ‘male domain’. Chazal, Guimond and Darmon (2012) concur with their findings that gender differences diminished in a same-gender social comparison condition and even impacted on subject selection in higher education with more females in single gender classrooms choosing to continue studies in higher mathematics.

In another study in the effects of single-gender classroom on subject progress, Van De Gaer, Pustjens, Van Damme and De Munter (2004) agree finding females make more progress in single-gender mathematics classrooms within single-gendered school.

Corresponding with these findings are the conclusions from an Australian study. Tully and Jacobs (2011) investigated the influences of females’ secondary school experiences on their choice to study engineering at university. With the support of both quantitative and qualitative data, it was found that a potential positive influence of single-gender school on a females’ choice to continue to study in the mathematics or science field. This study also reported that self-perception of mathematical skill and ability were higher in single-gender educated females and that single-gender classroom dynamics greatly benefitted females and impacted on their choice to continue to enrol and participate in mathematical science area.

Forgasz, Leder and Vale (2000) in a review of studies of single-gender interventions found that the teachers’ beliefs and behaviours were more important in achieving equity than the separation of genders in classrooms.

The importance of mathematics for new occupations in the technological world and the underrepresentation of girls in higher mathematics courses at school and university as discussed in the
introduction is the reason for the continuation of research into girls’ mathematics course enrolments. The research discussed in this chapter reveals there are several factors that are influencing girls’ choice of mathematics subjects. These include gender differences, gender stereotype, mathematics anxiety and test anxiety, pedagogy, parental influence, the value placed on mathematics, attitudes towards mathematics and self-efficacy. Through anecdotal evidence, there is anticipation that other factors including the importance of mathematics for university entrance and securing well paid occupations.

Hilltop Girls’ College Description

Hilltop is an all-female P-twelve College in Melbourne, Australia. The College charges relatively high fees for tuition and therefore the socioeconomic status of the community is high. Most of the parents are very well educated and aspire to give their children the same opportunity for a high-quality education. Hilltop is predominately attended by girls from families where English is the language spoken at home.

Hilltop is proud of the well-rounded and extensive opportunities it offers to its students, including comprehensive sporting, musical and art programs available for the students to participate in. While the students are encouraged to make the most of the opportunities at the College, one of its main priorities is to give the chance for all of its students to achieve academic excellence.

Hilltop has a very strong focus in achieving exceptional Australian Tertiary Admission Rank (ATAR) results and university entrance numbers at the end of each year. There is an understanding that the results at the end of Year twelve are a culmination of the education previous years. Therefore there is a strong academic focus across all year levels.

This focus is evident in Hilltop’s mathematics program. Extension classes are run for very strong students in Year seven and eight. This consists of students withdrawing from one class a fortnight to attend the special extension classes. Hilltop also has a learning support division where an extra teacher can join a mathematics class to work with weaker students in a small group.
Table 1 Class Descriptions

<table>
<thead>
<tr>
<th>Year 9 &amp; 10</th>
<th>Students</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Class or Group</td>
<td>Weak students</td>
<td>This class is designed to support the weaker mathematics students by moving through the curriculum at a slower pace. The class only has about 10 students.</td>
</tr>
<tr>
<td>Mainstream Class</td>
<td>Average/strong students</td>
<td>This class works through the curriculum at an average rate and usually has no more than 25 students.</td>
</tr>
<tr>
<td>AAE Class</td>
<td>Strong students</td>
<td>Accelerated Analysis and Extension. This class is designed to challenge strong mathematics students. The class moves through the curriculum quickly and uses the time to work on analysis and extension material.</td>
</tr>
</tbody>
</table>

In Year nine and ten, mathematics class are divided up into the ‘small class’, the ‘mainstream’ class and the ‘acceleration’ class. Strong students are given the opportunity to apply for the AAE (accelerated analysis and extension) class where the curriculum is accelerated and there is an opportunity for the students to engage in analytical problems. The weaker students are given an opportunity to be selected to be in a smaller group of only about ten students that moves slowly through the curriculum and sets them on the pathway to study General Mathematics B and possible Further Mathematics in Year twelve.

Half way through Year ten, the students are given the opportunity to select the General Mathematics pathway. This entails the girls ceasing to learn material that would lead to the Mathematics Methods course and only focus on the General Mathematics B course.
<table>
<thead>
<tr>
<th>Year 11 and 12</th>
<th>Students</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Mathematics B</td>
<td>Weak/ Average (strong) Students</td>
<td>Provides courses of study for a broad range of students. Is considered the ‘easier’ mathematics and leads into Further Mathematics. Areas of study include Statistics, Geometry and Trigonometry, Business Mathematics and Linear Relations.</td>
</tr>
<tr>
<td>Units 1 &amp; 2</td>
<td>GMB</td>
<td></td>
</tr>
<tr>
<td>Mathematical Methods 1 &amp; 2</td>
<td>Average/ Strong Students</td>
<td>Considered ‘harder’ mathematics and designed to prepare students for Units 3 &amp; 4. Areas of study include Functions and Graphs, Algebra, Rates of Change and Calculus and Probability. Some Accelerated Students study this subject in Year 10.</td>
</tr>
<tr>
<td>MM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Mathematics A</td>
<td>Strong Students</td>
<td>The main purpose of this subject is to prepare students for Specialist Mathematics and is considered the ‘hard’ or most difficult mathematics. Areas of study include Functions and Graphs, Algebra, Calculus, Vectors and Mechanics.</td>
</tr>
<tr>
<td>Units 1 &amp; 2</td>
<td>GMA</td>
<td></td>
</tr>
<tr>
<td>Subject</td>
<td>Students Level</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Further Mathematics Unit 3 &amp; 4</td>
<td>Weak/Average</td>
<td>Provides courses of study for a broad range of students. Is considered the</td>
</tr>
<tr>
<td>FM</td>
<td>(strong)</td>
<td>‘easier’ mathematics. Areas of study include Statistics, Geometry and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trigonometry, Business Mathematics and Linear Relations. Some students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>study this subject in Year 11.</td>
</tr>
<tr>
<td>Mathematical Methods Units 3 &amp; 4</td>
<td>Average/Strong</td>
<td>Considered ‘harder’ mathematics. Areas of study include Functions and</td>
</tr>
<tr>
<td>MM</td>
<td>Students</td>
<td>Graphs, Algebra, Rates of Change and Calculus and Probability. Some</td>
</tr>
<tr>
<td></td>
<td></td>
<td>accelerated students study this subject is Year 11.</td>
</tr>
<tr>
<td>Specialist Mathematics Units 3 &amp; 4</td>
<td>Strong</td>
<td>Considered the ‘hard’ or most difficult mathematics. Areas of study</td>
</tr>
<tr>
<td>SM</td>
<td></td>
<td>include Functions and Graphs, Algebra, Calculus, Vectors and Mechanics.</td>
</tr>
</tbody>
</table>

* See Appendix B for full subject descriptions.

Some Notes on Subject Selection at Hilltop College

Just before the end of Year ten, the students are asked to select their subject for Year eleven. This requires the students to select either Mathematics Methods unit 1 and 2, General Mathematics A unit 1 and 2, General Mathematics B units 1 and 2 or no mathematics at all. Hilltop College does not offer Foundation Mathematics (Year eleven basic numeracy) as a subject.
The students are asked to select their subjects for Year twelve at the end of term three the year before. Usually the students in Mathematics Methods will continue onto Units 3 and 4, while the General Mathematics B students continue onto Further Mathematics and General Mathematics A continue onto Specialist Mathematics.

The very strong students follow the AAE pathway through to Mathematics Methods unit 3 and 4 AAE and are encouraged to enrol in General Mathematics A and Specialist Mathematics in Year twelve.

When this research was conducted, there was only one Specialist Mathematics class at Hilltop comprising of ten students. The numbers for the following year looks like there is going to be a class of four. There are four Mathematical Methods unit 3 and 4 class with about 15 students in each and four Further mathematics classes with about 20 students in each.

There are 4 Mathematics Methods Classes unit 1 and 2 of about 18 students in each at Year eleven and 4 General Mathematics B class with about 20 students in each. There is only one class of General Mathematics A with ten students.

As mentioned earlier, the numbers for the advanced mathematics subjects have been declining over the last few years and this is a concern for Hilltop College.

This chapter cited numerous studies with the aim of highlighting the specific factors that have been shown through research to be influences on girls’ selection of mathematics subjects. This research project’s design was guided by these findings to investigate these factors in the context of Hilltop Girls’ College, a singles-sex college in Melbourne. These factors were used to inform the development of the qualitative nature of the project and the interview questions used in the investigation. It was expected that the responses to these questions would highlight the factors that influenced the choice of mathematics subjects of the students at Hilltop.
Chapter 3 Research Design

In this chapter, the methodology of this study will be discussed in detail. This includes justification of the methods used and the type of sampling employed. It also includes an explanation of the trustworthiness measures and analysis methods used. It concludes with the limitations of the study.

Methodology

The research examined in the Background: Literature and Study Context chapter provides insight and awareness of the factors that influence girls’ selection of mathematical subjects in secondary school. This study investigates Australian students in an Australian context with consideration of the issues discussed in the introduction. It adds an Australian perspective to the body of research in this field. The factors influencing the girls’ choice of mathematics courses were explored by a deep investigation of the associations between the selection of mathematics courses and the influences of the girls’ particular cultural and social environment.

With the aim of capturing students’ attitudes and relationships with mathematics, a method capable of allowing the students to use their own words to talk about mathematics and emphasis what they perceived to be important to their own experiences was required. This research, therefore, takes the form of ethnography. The aim of the research was to discover and faithfully represent the nature of social phenomena, not just to describe the context (Woods, 1999).

The research was conducted at Hilltop Girls’ College (pseudonym), a girls’ college in Melbourne. Hilltop is Kindergarten to twelve with Grade five to Year twelve on the main campus, with the exception of the Year nines. Hilltop has a separate campus which runs a Year nine program three kilometres from the main campus. By investigating adolescent girls’ attitudes and self-perceptions of mathematics and their ability in mathematics, meaning was made through their words and their existence within the context of the College they attend (Hughes, 2010).
This ethnographic study draws on discourse and narrative analysis approaches with the researcher being periodically *in situ*, immersing herself in the day-to-day running of the culture being studied. It lends itself naturally to the study of small-scale cultural investigations (Elliot, 2005).

The associations between the culture and attitudes of the school community, and the attitudes of particular students were studied. Data were collected to help explain the different ways the girls use their experiences of mathematics education, the language they use to discuss their attitudes towards mathematics, and the consequences of these attitudes for their selection of mathematics courses in upper secondary school.

Explaining the meanings and significance of the factors influencing girls’ course selection will help to understand the trends of the girls at this particular school through the common experiences and language they use (Elliot, 2010). The study was investigating if the discourses and culture of the school has contributed to the factors influencing the students preparing to select mathematics courses.

Central to the elements of ethnography is the investigation of cultural themes. It is important to have an understanding of the cultural context of the topic researched because using qualitative methods relies on looking at the ways knowledge has been created and sustained in this culture. How this has produced common attitudes towards mathematics at this school was explored. The significance of these attitudes needed to be uncovered with an understanding that the data collected is specific to the context in which it is gathered (Hughes, 2010).

**Interviews and achievement results.**

Data was gathered via interviews as they present first hand and first person accounts in narrative and engaging form. Due to the nature of the research, semi-structured interviews were used to facilitate open discussion of participants’ understandings and views, however, the interview was still kept on track ensuring the topics were addressed and the aims of the research were met (Krueger and Casey, 2009).
By using interviews the students’ narratives could be heard. The study of narrative is the study of the ways humans experience the world (Connelly and Clandinin, 1990). In educational research, the main claim for the use of narratives is the construction and reconstruction of personal and social stories; teachers and learners are storytellers and characters in their own and others’ stories (Connelly and Clandinin, 1990). Hiles and Cermak (2009) suggest narrative is essential to the meaning making process through which events and actions may be understood. Through narrative analysis, one is able to remain open to social processes that are present in the construction of personal narratives and embrace contradictions and multiple possibilities within narrative rather than seeking coherence (White and Epston, 1990).

As focus groups are not useful for accessing narratives and attitudes of individuals (Krueger and Casey, 2009), one-on-one interviews were conducted with twenty-three students from Years nine to twelve. The students in Year nine and Year ten were of particular interest. This is an important point in education because mathematics course selection occurs at this time. Year elevens and Year twelves were also interviewed to capture both the culture of Hilltop and also the consequences of their mathematics subject selection choices caused made under the influence of a range of influences.

Narrative/discourse is important to access as the emphasis in qualitative methods is on the discourses which make up social institutions and cultural products (Hughes, 2010). Interviewing is a powerful tool to capture the stories of the student and look at the ways they make meaning of their experiences (Rabionet, 2011).

The interviews were of a semi-structured nature. This kept the conversation focused on hearing the students’ experiences of mathematics and mathematics education but still allowed flexibility to hear all aspects of the students’ stories including perceptions, experiences and points of view (Rabionet, 2011). Therefore, qualifying, open ended questions were asked allowing students to position themselves as the authors of their experience were used.
The strengths of interviewing these students one-on-one were:

1) There is an opportunity to hear the students’ own perspectives of why they have made their decisions regarding mathematics choices,
2) There is an opportunity to line the data up against the researcher’s interpretations and assumptions (Rabionet, 2011).

Each of the students interviewed were asked to consider their experience of mathematics in relation to:

- Self-efficacy:
- Enjoyment/Likes
- Gender issues:
- Pedagogy:
- Mathematics Anxiety:
- Test Anxiety:
- Value of Mathematics:
- Parental Influence:
- Real Life Maths
- Work Context:
- Subject Selection:

To capture the culture of Hilltop, three teachers were interviewed. Each of the teachers interviewed were asked to consider their experience of teaching mathematics in relation to:

- Mathematics anxiety
- Test anxiety
- Pedagogy
- Gender issues
- Value of mathematics
- The culture of the College

To complete the triangulation, data of the mathematics results from the last three years of the students who were interviewed was also collected. This was to compare results to perceived mathematical ability. As the literature suggests, actual mathematical ability may be an influencing factor of subject selection (Crombie et al 2005, Eccles and Jacobs, 1986, Patrick,
Care and Ainley, 2011). This, therefore, provided interesting insights into the influence of self-efficacy and gender stereotypes on subject selections.

Participants.

Convenient and Purposeful Sampling.

For the purpose of this study, a relatively small sample was investigated, however, they were investigated in depth. As the intended focus of the study was on the factors that influence subject selection in mathematics, information-rich cases were pursued. Through the post-structural lens, it was not the intention to gain empirical generalisations, rather generate in depth understandings and insights from a small number of specific cases (Patton, 2002). Convenience sampling was used in choice of school selected as the researcher works at the College. A cross-section of students from Year nine to Year twelve and three teachers were selected to investigate the culture of Hilltop and the attitudes associated with mathematics. Maximum variation sampling was used (heterogeneity) as the central themes regarding the attitudes about mathematics were captured across several year levels. If there were patterns that appear across the whole school, these were valuable in representing the shared dimensions and experiences important to the research (Patton, 2002). Intensive sampling to find the information-rich cases that demonstrate the experiences of subject selection but are not extreme or unusual cases was also used (Patton, 2002). Students with sufficiently interesting stories to help elucidate and uncover the interesting experiences of selecting subjects in secondary school were selected (Patton, 2002).

Summary of Participants.

When sampling particular students to participate in the one-on-one interviews, the particular years that make important and determining subject selections in regards to mathematics were focused on. Therefore, six Year nine students, ten Year ten students, four Year eleven students and five Year twelve students were interviewed. The information-rich cases interviewed included:
• A very strong mathematics student who did not select an advanced mathematics subject in senior secondary school.
• A student who did not choose a mathematics subject due to mathematics anxiety
• A student who chose advanced mathematics despite the apparent low ability
• A student who chose advanced mathematics despite a dislike for the subject.

Table 3 provides a key of the ability levels of the students selected to participate in this study. Table 4 to 7 provide summaries of the participants of the study from Year nine to Year twelve. Table 8 provides a summary of the description of the teachers participants of the study.

Expanded descriptions of each of the participants and the mathematics subject results of the participants have also been included. The student participant descriptions derive from varies sources. These include the students’ responses from the interview, the students’ results from this and previous years and the researchers’ observations.

**Table 3 – Key for the participants of the study**

<table>
<thead>
<tr>
<th>Student Ability</th>
<th>Results for three years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Strong</td>
<td>A+ and As consistently</td>
</tr>
<tr>
<td>Strong</td>
<td>A and Bs consistently</td>
</tr>
<tr>
<td>Average</td>
<td>B and Cs consistently</td>
</tr>
<tr>
<td>Weak</td>
<td>C and Ds consistently</td>
</tr>
<tr>
<td>Very Weak</td>
<td>D and below consistently</td>
</tr>
</tbody>
</table>
Table 4 - Year 9 participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Year Level</th>
<th>Type of Class</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloe</td>
<td>9</td>
<td>Accelerated</td>
<td>Very Strong</td>
</tr>
<tr>
<td>Emily</td>
<td>9</td>
<td>Accelerated</td>
<td>Strong</td>
</tr>
<tr>
<td>Tahlia</td>
<td>9</td>
<td>Mainstream</td>
<td>Strong</td>
</tr>
<tr>
<td>Ella</td>
<td>9</td>
<td>Mainstream</td>
<td>Strong</td>
</tr>
<tr>
<td>Georgia</td>
<td>9</td>
<td>Small Group</td>
<td>Very Weak</td>
</tr>
<tr>
<td>Tamara</td>
<td>9</td>
<td>Small Group</td>
<td>Very Weak</td>
</tr>
</tbody>
</table>

**Brief Description:**
- Chloe: Loves mathematics
- Emily: Not enjoying the accelerated class, poor results this year
- Tahlia: Chose not to go into extension group
- Ella: Apathetic about mathematics
- Georgia: Hates mathematics
- Tamara: Tries very hard

*Year 9 Student Participants’ Descriptions.*

**Tahlia.**

Tahlia has always been a strong mathematics student. She has always found the subject easy and concepts seemed to come to her naturally. This is the first year she has felt challenged by mathematics; things are not coming to her as easily now. While she was approached to go into the extension class this year, she decided she would prefer to do very well in the mainstream class than have to “work too hard” in the extension class. Tahlia is strongly encouraged by her parents to continue to study mathematics. She “has to do well” in this subject and she is not allowed to miss mathematics for music classes or any other reason.

**Chloe.**

Chloe is a very strong mathematics student. She has always had success in the subject and is often the strongest student in the class. This year, she was selected to attend the acceleration group but she now feels the work is hard and she is not achieving the same results as previous years. She still enjoys mathematics, citing it as her favourite subject. Chloe’s parents are both very strong mathematicians and she says that her achieving in the subject is very important to them.
**Ella.**

Ella is a strong mathematics student, however, she is “very stressed” about studying mathematics. While her results from previous years indicate she is a strong student, she does not think that she is very good at mathematics. Ella thinks there is a large workload for mathematics and when she cannot get it all done due to other commitments, she feels behind. She says she never wants to fail a mathematics test and she does not want to be the one asking questions in class. Ella says she will continue to study mathematics because it will “seem like you’re stupid or something if you don’t.”

**Emily.**

Emily was selected to be in the acceleration group this year but she is not enjoying it. She says she is finding the standard too challenging and feels that her results have suffered. Her results indicate she has been a strong student in the past. Emily has been getting test anxiety as she knows she is not going to do very well. She cannot see when she is ever going to use the mathematics she has been learning again but realises she may need a mathematics subject in Year twelve.

**Georgia.**

Georgia hates mathematics. She says she is “hopeless” at it and she dreads going to class. Her results indicate that she is a weak. She takes much longer than her peers to complete the same amount of work and she resents how much works she has to do for the subject. Georgia sees no purpose for her continuing to with mathematics other than it might get her “a good job”.

**Tamara.**

Tamara is a weak student. While she feels she does work hard, her results fluctuate between very poor and average. She is more engaged in the subject if the topic interests her. She thinks mathematics is important to get “my dream job” and her parents tell her it is important even though she is not excelling in the subject.
Table 5 - Year 10 participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Year Level</th>
<th>Type of Class</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlotte</td>
<td>10</td>
<td>Accelerated</td>
<td>Very Strong</td>
</tr>
<tr>
<td>Sienna</td>
<td>10</td>
<td>Accelerated</td>
<td>Strong</td>
</tr>
<tr>
<td>Alexis</td>
<td>10</td>
<td>Mainstream</td>
<td>Strong</td>
</tr>
<tr>
<td>Emma</td>
<td>10</td>
<td>Mainstream</td>
<td>Strong</td>
</tr>
<tr>
<td>Mia</td>
<td>10</td>
<td>Mainstream</td>
<td>Strong</td>
</tr>
<tr>
<td>Olivia</td>
<td>10</td>
<td>Mainstream</td>
<td>Weak</td>
</tr>
<tr>
<td>Ruby</td>
<td>10</td>
<td>Small Group</td>
<td>Average</td>
</tr>
<tr>
<td>Sophie</td>
<td>10</td>
<td>Small Group</td>
<td>Very Weak</td>
</tr>
</tbody>
</table>

**Brief Description:**
- Charlotte: Enjoys mathematics
- Sienna: Moved back to mainstream, loves mathematics now
- Alexis: Enjoys mathematics
- Emma: Anxious about mathematics, tries hard
- Mia: Never liked mathematics before, has confidence issues
- Olivia: Works hard and wants to be a doctor
- Ruby: Moved from Mainstream, confidence an issue
- Sophie: Does not mind mathematics

**Year 10 Student Participants’ Descriptions.**

**Alexis.**

Alexis enjoys mathematics. She says that she particularly likes it when she has a good teacher and a friendly environment. She enjoys short answer questions but dislikes analytical or extended questions. Alexis is a good student achieving mainly Bs and As. She thinks she will continue to study mathematics into VCE by enrolling in Mathematical Methods.

**Emma.**

Emma is an enthusiastic student who achieves high results in mathematics. She thinks she will study two mathematics subjects next year, Mathematics Methods 1 & 2 and Further Mathematics, because she is “more of a mathematical person than a humanities person”. Emma does not like the amount of homework she gets for mathematics and enjoys the analytical questions more than the repetitive textbook questions.
Ruby.

Ruby does not enjoy mathematics. Her results are very inconsistent and she does not have confidence in her mathematical abilities. She finds that if she works hard and completes all her homework, she achieves better results. Neither of her parents studied mathematics in Year eleven or twelve and therefore are not encouraging her to continue with mathematics in VCE. Ruby wants to continue to, however, because it “opens more doors”.

Mia.

Mia is a strong student of mathematics but she dislikes the subject. She is a very creative person excelling in art. While she achieves good results, she doubts her abilities in mathematics. She feels if she pushed herself harder, she would improve. Mia does not like the structured nature of mathematics and dislikes the amount of work required. She becomes anxious about mathematics tests and is only continuing to study the subject to “get a good ATAR” and “get into a good university course”

Olivia.

Olivia is a weak mathematics student. She says she understands concepts when she is in class and doing her homework, but has trouble in tests. She consistently underperforms in assessment. Olivia suffers from test anxiety, particularly if she values the subject. Olivia likes it when teachers make the class enjoyable and relevant. Her father is very good at mathematics and encourages her to continue to study the subject. Olivia would like to continue into Mathematical Methods and she does not think Further Mathematics “has any jobs” and she would like to enrol in Medicine at university.

Charlotte.

Charlotte is a very strong mathematics student. She is in the accelerated class in Year ten. She loves the structured and repetitious nature of the subject but is not as fond of analytical questions. She likes to work out of a textbook and does not feel the teacher is relevant as the subject is structured; “you know what to do.” Charlotte does not suffer from test anxiety if she feels prepared. While she achieves excellent results in mathematics, she does not think she will study Specialist Mathematics in VCE because it will be “too hard”.

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Sophie.

Sophie is a weak student who has been in the ‘small group’ and General pathway since Year nine. She does not see the point of mathematics other than “getting into a good course”. She suffers from text anxiety, particularly due to the comparison with other students. Sophie says she will continue to study General Mathematics B and Further Mathematics in VCE because most courses need mathematics and “it is good to have it behind you.”

Sienna.

Sienna is a strong student who says mathematics is her favourite subject. She says she will continue to study Mathematical Methods in VCE as she is “not a humanities person” and it is a prerequisite for many courses. Sienna can become overwhelmed before tests and exams and she really wants to do well in this subject. It is more important to her than all of her other subjects. Sienna was in the accelerated group because she was convinced by family members that she should not “waste the opportunity”, however, she has since moved back to the mainstream class.

Table 6 - Year 11 participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Year</th>
<th>Type of Class</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ava</td>
<td>11</td>
<td>GMB</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Brief Description:</strong> Very capable of methods but chose GMB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dana</td>
<td>11</td>
<td>MM</td>
<td>Very Weak</td>
</tr>
<tr>
<td><strong>Brief Description:</strong> Advised against MM after achieving less than 33% in Yr10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katrina</td>
<td>11</td>
<td>MM &amp; GMB</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Brief Description:</strong> Chose both MM and GMB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hannah</td>
<td>11</td>
<td>GMB</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Brief Description:</strong> Capable of MM but chose GMB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Year 11 Student Participants’ Descriptions.**

*Ava.*

Ava is a strong mathematics student who chose to study General Mathematics B instead of Mathematical Methods. She enjoys it much more now because she does not feel as stressed because she “gets it”. Ava said she continued with mathematics into VCE as it will “keep doors open” but was not interested in courses that required a higher level of mathematics.

*Dana.*

Dana is a very weak mathematics student who chose to continue to study Mathematical Methods against the recommendation of Hilltop’s mathematics staff. She realises she is not strong at mathematics and needs to work very hard. Dana is often anxious about mathematics and tests. She believes this happens more when she “doesn’t know what’s going on”. Her father has a degree in mathematics and is encouraging Dana to continue her studies. Dana says she will continue as it “gives more openings in life.”

*Katrina.*

Katrina is a strong student who studies both Mathematical Methods and General Mathematics B in Year eleven. She achieves very good results for General but finds Methods a lot harder. She does a lot more work for Methods but achieves lower marks. She likes the logical nature of mathematics but feels she works slowly because she wants to get everything right. Katrina wants to enrol in Mathematics Methods next year to “keep her options open” but feels she is leaning towards Further Mathematics because there will be less of a workload.

*Hannah.*

Hannah is an average student who is studying General Mathematics B in Year eleven. She does not see the point of “crazy maths” and cannot see how this is used in real life. As she was studying a 3 & 4 subject this year, she did not want to study Mathematical Methods as the workload would have been too great. Hannah has not suffered from mathematics or test anxiety this year as she finds the work quite easy. She also likes the fact that General Mathematics has a resource book.
**Table 7 - Year 12 participants**

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Year</th>
<th>Type of Class</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoe</td>
<td>12</td>
<td>FM</td>
<td>Strong</td>
</tr>
</tbody>
</table>
| **Brief Description:** Chose MM but moved to FM in Year 11
| Amelia    | 12   | FM            | Strong  |
| **Brief Description:** Chose FM while capable of MM
| Lucy      | 12   | FM            | Weak    |
| **Brief Description:** Did not need FM but chose it anyway
| Phoebe    | 12   | MM            | Average |
| **Brief Description:** Thought about doing FM but chose MM

**Year 12 Student Participants’ Descriptions.**

*Phoebe.*

Phoebe is an average student and she says Mathematical Methods is her least favourite and worst subject. The only reason she enrolled in Mathematical Methods this year was to “keep her options open.” If it was not a prerequisite to university courses she was interested in, she would not have done it and instead chosen an easier subject. Phoebe thinks the teacher is very important to the learning and enjoyment of a student. While she likes the “right or wrong” nature of mathematics, she dislikes the workload involved in achieving her best results. Phoebe gets very anxious before assessment as she wants to do well in this subject.

*Amelia.*

Amelia is a strong mathematics student who chose to enrol in Further Mathematics this year. While she achieves good results, she really dislikes the subject. She did not see the relevance of the higher level mathematics but can see some use for Further Mathematics. She, however, wishes she had continued with Methods because, at the time of subject selection, she did not realise that it is a prerequisite for many of the courses she is now interested in. Amelia is very independent and learns from the textbook at her own pace. She says she is not putting in the work that she should be to reach her full potential.
Zoe.

Zoe enrolled in Mathematical Methods at the start of Year eleven but changed to General Mathematics B midyear. She did this because she realised she did not need the higher mathematics for the course she wanted to study at university and Methods required a lot of work. Zoe is a very strong mathematics student, currently achieving the higher results in her class. She says she does not put much effort into the subject as she finds the work easy and completes it all during class.

Lucy.

Lucy is a weak student who only chose to study Further Mathematics because she had room in her timetable and she thought it might give her “something extra.” She does not need it for the university course that she will be applying for. Lucy does not enjoy the subject as she finds it “a bit dry” but does get a little anxious before assessment.

Table 8 – Teachers participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Years at Hilltop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen</td>
<td>Over 30</td>
</tr>
<tr>
<td></td>
<td><strong>Brief Description:</strong> Has been at Hilltop for whole career. Has previously been Head of Department.</td>
</tr>
<tr>
<td>Margaret</td>
<td>Over 10</td>
</tr>
<tr>
<td></td>
<td><strong>Brief Description:</strong> Very experienced teacher. Teacher Science also.</td>
</tr>
<tr>
<td>Michelle</td>
<td>4 years</td>
</tr>
<tr>
<td></td>
<td><strong>Brief Description:</strong> Teaches Year 5 – 9 Mathematics</td>
</tr>
</tbody>
</table>

Teacher Participant Descriptions.

Margaret.

Margaret is a very experienced teacher. She has taught for over 30 years and has been at Hilltop for over 15 years. Margaret is qualified to teach mathematics and science from Grade five and has mathematics classes from Year seven to Year eleven this year.
Helen.
Helen has been at Hilltop for over 30 years. She has been the Curriculum Leader of Mathematics previously and is an excellent mathematics teacher at all levels. She is currently teaching mathematics at all year levels.

Michelle.
Michelle has been teaching for less than eight years and has been at Hilltop for half that time. She has taught mathematics from Grade five to Year nine.

Ethics

Permission for data collection.

In regards to gaining access to the research site and participants, the following considerations were made:

- The research satisfies the ethical requirements of the University of Melbourne. (see appendix B) A minimal risk application was made to the Melbourne Graduate School of Education Human Ethics Advisory Group (MGSE HEAG). The application’s code number is 1330309. Within this application was the permission to collect data from the students and staff of the College via semi-structured interviews.

- The research gained permission from the Catholic Education Office Melbourne (see appendix B). The code number of the application is 1899. It was made clear in this application that data was to be collected from the students and staff of the College via semi-structured interviews.

- The researcher gained permission from the Principal of the College to allow observations and fieldwork to occur. There was an interview with the Principal to discuss ethical considerations and the method of collecting data from students and staff from the College. A Plain Language Statement was then given to the Principal to gain formal consent to conduct interviews in the College for the purpose of collecting data for this research project. (see appendix B)

- Informed consent was obtained from the participants of the study. For students, this meant gaining consent from them as individuals and from their parent/caregivers. The Plain Language Statement was given to the students and parents to inform them of the purpose of the research project and to gain
consent for students’ participation in an interview to collect data for the research project. This statement also made it clear that while the participant may know the researcher, or may have a dependent relationship with the researcher, the responses will in no way affect future course selection or future results. This was reiterated again just prior to the interview with the participant, clarifying that while the researcher was a teacher at the school and for some participants their mathematics teacher, the responses given should be honest as this will not affect results or future subject selection.

Data Presentation and Analysis.

Description and Presentation.

A description of Hilltop is given in Chapter 2 to illustrate the culture and the setting of the College. This is because the setting is the starting point for qualitative research. Giving a picture of the setting enables the reader to see through the eyes of the researcher and to paint a picture rich with content in terms of the context and locale (Creswell, 1998).

While the data produced from semi-structured interviews with students and teachers, in addition with the students’ results, provided deep conversations and important information, these have not been included in their entirety. The results chapter gives a representative illustration of the participants’ responses and results via summaries and extracts from the interviews together with some analysis. Two samples of full transcripts, one from a student and one from a teacher, have been included in Appendix F and G.

Analysis.

Discourses are spoken practices which categorise cultural practice concerned with ways knowledge is created and sustained in cultures. Analysis involves trying to get inside the texts and track the processes by which it has been constructed and the influences that have constituted its production. It is seeing how the information is grouped together into meaningful entities and comparing them to find gaps or missing pieces (Grbich, 2004).
After actively listening to and reading the data many times, codes were created with the intention of grouping them to make deeper interpretations. This involved dissecting the transcripts of the interviews in a meaningful way but still keeping the context intact (Hurworth, 2008). A quantifiable measure is not necessarily used as an indicator of the importance of a ‘theme’. Rather, the ‘theme’ is deemed important if it captures something important in relation to the research (Braun and Clarke, 2006).

**Validity and Trustworthiness.**

Traditional validity is maintained in the following ways:

- Employment of various methods of collecting data and various sources of data.
- Recording of interviews and verification of the authenticity of the interview transcripts via a letter of attestation provided in the appendix. (appendix C)

Interpretive paradigm; however, does not tend to work within the conventional, positivistic criteria of internal and external validity, reliability and objectivity. Instead, it considers the term ‘trustworthiness’ (Denzin and Lincoln, 1994, Lincoln and Guba, 1985, Padgett, 1998). While the concept of ‘validity’ is essential for the evaluation of rigour, it is associated with post-positive and statistical research paradigms (Denzin and Lincoln, 2005). Therefore, for this study, trustworthiness and authenticity are used as more applicable standards to assess this style of research.

The four factors of trustworthiness as suggested by Denzin and Lincoln (1994) for this paradigm include: Credibility, Transferability, Dependability and Confirmability.

**Credibility.**

Credibility refers to the confidence one has in the findings. Triangulation and member checking has been used to achieve this factor.
**Triangulation.**

In order to be more confident in the study’s findings, data were collected from multiple sources. Interviews with students from the College were the main data-gathering method while interviews with teachers from the College were conducted to get an authentic impression of the culture of the College. To complete the triangulation, achievement results from the participating students from the previous three years were used to provide an indication of the participants’ abilities and level of achievement in the subject.

**Member Checking.**

Feedback was obtained from people in the College who commented on the analysis and interpretations. The Deputy Principal: Learning and Innovation, the Mathematics Curriculum Leader and an experienced teacher from the College were asked to comment on the findings.

**Transferability.**

Transferability refers to the ability of other researchers to apply the findings to their own study. Descriptions of the participants and purposeful sampling were used to achieve this factor. Reflection of the results in light of previous research was also carried out and discussed in the analysis and conclusion chapters.

**Descriptions.**

Presenting descriptions of the participants in the research provides a data base for transferability judgments (Lincoln and Guba, 1985). They give powerful representation of the individuals in their social and cultural environment. By combining the analysis of their narrative with these descriptions, it allows us to explore beyond the surface and provides us with a vicarious experience (Lincoln and Guba, 1985).
Purposeful Sampling.

As mentioned earlier, purposeful sampling was used in this study. While conventional quantitative paradigm relies on random sampling, the interactive paradigm intentionally finds both typical and divergent data to increase the range of information obtained about the context.

“The object of the game is not to focus on the similarities that can be developed into generalisations, but to detail the many specifics that give the context it’s unique flavour” (Lincoln and Guba, 1985).

Dependability and Confirmability.

Dependability refers to the stability of the findings over time and confirmability to the internal consistency of the data in relation to the findings, interpretations, and recommendations (Denzin & Lincoln, 1994). Dependability and confirmability can simultaneously be obtained by keeping meticulous records to create an audit trail (Lincoln & Guba, 1985; Padgett, 1998).

This trail includes:

- Raw data including recordings of the interviews and certified transcripts of these interviews (via the letter of attestation).
- Data reduction and analysis products including interview summaries and coding tables.
- Data reconstruction products.
- Process notes.
- Rough drafts of all elements of the study.

Method

Semi-Structured Interview Questions.

The questions that were used by the researcher to gather for the purposes of investigating the research questions are given below:
### Student Questions.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy:</td>
<td>How are you going in Mathematics this year?</td>
</tr>
<tr>
<td>Enjoyment/Likes</td>
<td>What do you enjoy/dislike about Mathematics at Hilltop?</td>
</tr>
<tr>
<td>Gender issues:</td>
<td>Do you think there are gender differences when it comes to mathematics?</td>
</tr>
<tr>
<td>Pedagogy:</td>
<td>Do you think teachers make a difference to mathematics achievement? How?</td>
</tr>
<tr>
<td>Mathematics Anxiety:</td>
<td>Do you get anxious about mathematics? What makes you anxious?</td>
</tr>
<tr>
<td>Test Anxiety:</td>
<td>How do you go in tests and exams situations?</td>
</tr>
<tr>
<td>Value of Mathematics:</td>
<td>Do you see the value of studying mathematics?</td>
</tr>
<tr>
<td>Parental Influence:</td>
<td>Mum and Dad, what do they think?</td>
</tr>
<tr>
<td>Real Life Maths</td>
<td>Can you see when Mathematics is used in real life?</td>
</tr>
<tr>
<td>Work Context:</td>
<td>Do you know any jobs that use Mathematics?</td>
</tr>
<tr>
<td>Subject Selection:</td>
<td>What subjects are you going to select next year and why did you choose them? What were your reasons for your subject selection?</td>
</tr>
</tbody>
</table>

### Teacher Questions.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics and Test anxiety</td>
<td>Is there a culture of mathematics anxiety at Hilltop? What evidence do you have of this?</td>
</tr>
<tr>
<td>Testing and Assessment</td>
<td>Does Hilltop test too much?</td>
</tr>
<tr>
<td>Self-efficacy/Confidence</td>
<td>Do the girls at Hilltop have an issue with self-confidence?</td>
</tr>
<tr>
<td>Gender Issues</td>
<td>Do you see a difference between males and females? Is there a difference at Hilltop because the males are absent?</td>
</tr>
</tbody>
</table>
Subject Selection

Do you see girls choosing inappropriate subject? What are some of the reasons why?

This chapter outlines the methodology of this study. It gives justifications for the decisions made about choice of paradigm, methods used and sampling type. It also gives a succinct explanation of the research trustworthiness and authenticity.
Chapter 4 Results with Links to Literature

The purpose of this chapter is to present and discuss the data gathered from the semi-structured interviews of the students and the teachers of Hilltop College, and the summary of mathematics results of the students. The intention is to respond to the research questions:

1. What are the factors that influence secondary school girls’ mathematics subject selection?

2. How does the mathematics culture of the school influence these selections?’

The students’ and teachers’ responses to the specific questions will be presented to unearth the factors that influence girls’ mathematics subject selections. They will be built into a discussion to provide insight into the subject selection process linking to previous research findings discussed in the background chapter and draw some general conclusions from examining the responses. The implications of these responses will be discussed and analysed in more detail in the following analysis chapter.

Student Results

Table 9 below summarises the students’ results over a period of at least three years and up to five years prior to this study. Students, like Tahlia, were classified as mathematically strong because over time, she has consistently achieved the grade of As or Bs. Students, like Hannah, were classified as mathematically average because over time, she has consistently achieved the grade of Bs and Cs. Students, like Olivia, were classified as weak because over time, she has consistently achieved the grade of Cs and Ds.
<table>
<thead>
<tr>
<th>Pseudonyms</th>
<th>Year 7 Sem 1</th>
<th>Year 7 Sem 2</th>
<th>Year 8 Sem 1</th>
<th>Year 8 Sem 2</th>
<th>Year 9 Sem 1</th>
<th>Year 9 Sem 2</th>
<th>Year 10 Sem 1</th>
<th>Year 10 Sem 2</th>
<th>Year 11 Sem 1</th>
<th>Year 11 Sem 2</th>
<th>Year 12 Sem 1</th>
<th>Average</th>
<th>Ability Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tahila</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>strong</td>
</tr>
<tr>
<td>Chloe</td>
<td>A+</td>
<td>A+</td>
<td>A+</td>
<td>A+</td>
<td>A+</td>
<td>A(accel)</td>
<td>A+</td>
<td>A(accel)</td>
<td>A+</td>
<td>A+</td>
<td>A+</td>
<td>A+</td>
<td>very strong</td>
</tr>
<tr>
<td>Eliza</td>
<td>D</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>D</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>D</td>
<td>D</td>
<td>B</td>
<td>D</td>
<td>very weak</td>
</tr>
<tr>
<td>Emily</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>C(accel)</td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>C</td>
<td>strong</td>
</tr>
<tr>
<td>Georgia</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>very weak</td>
</tr>
<tr>
<td>Tamara</td>
<td>D</td>
<td>D</td>
<td>B</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>very weak</td>
</tr>
<tr>
<td>Alexa</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B+</td>
<td>B+</td>
<td>strong</td>
</tr>
<tr>
<td>Emma</td>
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Grades Key: A+ 90 - 100%  
A+ 80 - 89% key: Accel Accelerated class for the stronger students  
B+ 75 - 79% small smaller class for the weaker students  
E 70 - 74% GMB General Mathematics B class  
C+ 65 - 69% NM Mathematical Methods Class  
C 60 - 64% FM Further Mathematics Class  
D+ 55 - 59%  
D 54 - 54%  
E 40 - 44%  
E 35 - 39%  
UG < 34%
Student Responses

How are you going in mathematics this year?

The Year nine students’ responses to this question depended on their test results with all students making a comment about their grades they had achieved so far this year. Tahlia, Chloe, Ella and Georgia commented that the work they have done this year has become harder and they were not prepared for the rise in standard. Tahlia continued saying she did not realise she had to work harder to maintain her standards. Chloe said she was going worse than last year and that she is not sure if she is good at mathematics. Chloe’s results have dropped slightly from A+s to As, however, she is now in the accelerated group and therefore the complexity and workload has increased. She does not recognise that she continues to be a strong mathematics student, instead, she does not know if she is good at it due to her ‘results’. This is consistent with Brown and Joseph (1999) who suggest that women are typically less confident in their mathematics abilities.

Many of the Year tens, however, said they were going well even though they did not feel like their test results were very good. There is an indication that there are different reasons for their feelings about mathematics, not just results. Alexis, Emma, Olivia and Sophie seem to base their feelings solely on their achievement while Sienna and Ruby seem to cite other reasons for their feelings, for example, the atmosphere of the classroom or improvement in results. Ruby said she was not achieving as higher grades as previous years but enjoyed mathematics more this year.

Interviewer: Have you always liked or disliked maths?
Ruby: Um, I’ve always not really liked it but found it not that hard I just don’t really like it. Um, this year I like it a bit more even though I’m doing worse which is a bit weird whereas last year I liked it less but did better.

Interestingly, Mia and Ava say they are not going very well this year, however, their results indicate otherwise. Mia says that she is not going very well and could go better; however, her results indicate that she is averaging over 80% in assessments for the semester. Similarly, Ava says she is going “just ok” but is averaging 90% in assessments for the semester.
This reflects the findings from Marsh and Yeung (1998) that girls can have low mathematics self-concepts.

The senior students studying Mathematics Methods all said they were “going ok”. None of the students mentioned learning anything of interest in mathematics this year or that they were going well this year due to some kind of improvement. All responses were related to results and achievement, not learning experiences demonstrating they see a difference between learning mathematics and seeing themselves as mathematicians. These responses indicate that very few of the girls have a genuine interest in the subject reflecting Forgasz and Leder (1996). In response to research question 1, the atmosphere of the classroom, that is a supportive and enjoyable mathematics class, was important to some of the girls.

**What do you like or dislike about mathematics this year?**

Mathematically strong students mentioned the structure and methodical nature of mathematics as something they liked. The fact that “you can be right or wrong” was mentioned by Phoebe and Tahlia as a part of mathematics they liked. Chloe liked the fact that “there is a way” and “one correct answer” while Tahlia liked the methodical quality of mathematics. Charlotte likes the fact that there is one way to work out a problem and there are particular steps to follow. She likes the structure of mathematics. This seems to contradict Steele and Arths (1998) and Chapman (2001) who suggested this structured teaching approach (of explaining the problems, doing the problems, memorizing the algorithms, correcting the problems, and testing for correct methods) is a major source of mathematics anxiety.

Interestingly, two weaker students, Sophie and Tamara, and a strong accelerated student, Emily, commented that they dislike the structured nature of mathematics. Sophie wished that teachers would explain other ways to do problems because sometimes she does not do the problem the same way. Tamara said there is a lot to remember and she gets confused and Emily hates to rote learn formulas; “I’m not good at remembering stuff”. This reflects the lack of analytical, innovative and enterprising thinking in the curriculum. A student may be an excellent rote learner but the workforce of tomorrow requires more from its employees. Students who may not be
good at remembering formulas may be considered weak, even though they may be quite good at analytical thinking but have had minimal exposure and therefore have not had an opportunity to display and develop these important skills.

Amelia and Sophie perceived a lack of transferability of learned concepts to the ‘real world’. Both participants said they do not like the fact that they see no point to what they are learning in mathematics. Amelia says she is “never going it use it again” and Sophie says she gets frustrated because she cannot see the point in learning some of the concepts. Considering the suggestion that many industries will demand mathematical thinking in some form and the importance to the future workforce, it is interesting that the students’ perceive little reason for learning mathematics. They cannot see how they are going to use what they are learning in real life supporting Boaler (1997). Sophie says “if I don’t need it, I don’t enjoy it”. Again this reflects the way which mathematics is taught with no emphasis being placed on the importance of mathematics in this modern workforce.

A common response was for the students to think there is too much work in their mathematics subjects saying they spend hours on mathematics homework. Georgia, Charlotte, Mia, Emma and Phoebe all said they disliked the amount of time they spend on mathematics homework.

The strong senior students, Ava and Katrina, who chose General Mathematics B, said they enjoyed it while the weak or average students, Dana and Phoebe, who chose Mathematical Methods, do not enjoy it at all. It appears the strong or average students who have chosen an ‘easier’ mathematics subject like the class but the weak or average students who chose the ‘harder’ mathematics subject do not like the class.

Amelia, Zoe and Lucy, who are all studying Further Mathematics, said they do not enjoy it and, as a consequence, are probably not putting in the work required to achieve their best results. Lucy suggests it was “so dry”. Koller, Baument and Schnabel (2001) suggested interest was an important determinant of course selection and learning, however, the senior students do not seem to have an interest in the subject at all yet have still chosen to study mathematics.
These responses give a picture of the culture of mathematics at Hilltop (research question 2). The learning stories presented throughout the interviews indicated that the mathematics pedagogy is very structured with an emphasis on rote learning. Much of the content is of an abstract nature with few links made to real life mathematics. Many of the girls’ described a very heavy workload associated with the subject and little interest in the mathematics itself.

Do you see a difference between males and females in relation to mathematics?

While some of the girls said they thought males were better at mathematics than females, the explanations for this tended to be vague or non-existent; they were not sure why. Emma suggested that females were very imaginative while males are more straight forward and mathematical. Ruby said she has never heard a male say he hated mathematics and that males just do mathematics the way they are told, while females have open minds and question more. Ruby said mathematics comes more naturally to males. Olivia said that in primary school, males just seem to be better at mathematics than females; they were more competitive. This may reflect societies’ belief reported by Brown and Joseph (1999) about gender and mathematics; that most people think males are better at mathematics than females. Tahlia talked about how in primary school she found the females were very competitive and she was not sure if the males were like that. The literature suggests the opposite with Boaler (1997) finding females tend to prefer cooperative learning activities whereas males prefer competitive ones.

Olivia and Chloe both mentioned primary school saying the males were more competitive then and they liked mathematics more than the females, however, they said they were not sure about now they attend Hilltop, an all-female secondary college. Georgia, Tamara, Phoebe and Sophie all mentioned their brothers saying they were a lot better than them at mathematics so maybe in general males are better than females at mathematics. Ella and Georgia both mentioned that “boys’ jobs” are mathematical so males are better at mathematics. As Cohen (2005) suggested, these responses may stem from the belief that mathematics ability and mathematical applicability comes from socially transmitted
messages that are repeated by parents, peers, and popular culture. Tamara said she thought males were smarter but messier and less organised.

A noteworthy response to this question was when Mia mentioned that her Year seven mathematics teacher would spend a lot of time in class talking about how males are better than females at mathematics demonstrating how this stereotype was made explicit.

**Interviewer:** Do you think there’s any difference with genders, with maths?

**Mia:** Um, well Mr Jones’s* convinced that, um, that boys are better than girls.

**Interviewer:** Really? Mr Jones* thinks that does he? What is his reason for that?

**Mia:** I don’t know but he just spent a lot of Year 7 and 8 that boys are better than girls ‘cause they think more logically or something.

**Interviewer:** Do you see evidence of that?

**Mia:** I don’t know, I’ve never seen boys do maths?

**Interviewer:** Okay, do you see girls that are good at maths?

**Mia:** Yeah.

**Interviewer:** Many of them?

**Mia:** Yeah.

**Interviewer:** At this school?

**Mia:** Yeah.

*not real name

As Brown and Joseph (1999) suggested, with such institutional support for stereotypes of gender differences in mathematical abilities, it is no surprise that a female student may give this type of response. Shapiro and Williams (2011) agreed stating that females interacting with someone who holds a negative stereotype of females can result in continually being explicitly reminded of a gender stereotype.

Many of the girls said they cannot see how males are better than females at mathematics. Hannah, Ella, Olivia and Charlotte said because they go to Hilltop, a female college and do not have brothers, they have not
seen males in mathematics classes and therefore they do not feel that they can compare the genders. Charlotte, Hannah and Ava said it depends on the person; both males and females can be good at mathematics. Ava said it is not the gender that is important but the work ethic. This reflects the discourse of individuality and individuality freedom as mentioned in Frances (2000) and Brinkworth (1999) finding that students believed hard work would achieve success regardless of gender.

Zoe said all the males she knows have selected Mathematical Methods for Year eleven and twelve and many of the females she knows have selected Further Mathematics. This is regardless of the fact she goes to Hilltop where many females have chosen to study Mathematical Methods. This may suggest that the stereotype is evident for the older students agreeing with Bradell and Staberg (2008).

When considering research question 1, mathematics as a ‘male domain’ may not obviously be considered as a factor that influences subject selections. The stereotype seems to be subtle with some girls suggesting that males are ‘better at mathematics’ while others said gender does not matter. However, while a bias does not appear to be explicit at Hilltop, there may be a subtle suggestion of bias in the culture (research question 2).

**Do you think the teacher makes a difference?**

Tahlia said her Grade five teacher changed her opinion of mathematics and increased her ability.

**Interviewer:** Do you think teachers make a difference in your maths learning and maths enjoyment?

**Tahlia:** Definitely, because I, in when I came to Hilltop in Year four I didn’t really understand maths and then in Year five I had Mr Collins* and that changed it completely. Cos [because] I thought he was a really really really good teacher.

**Interviewer:** What was it about him that you liked?

**Tahlia:** Methodical. I thought, yeah, and just like really, I don’t know, I just, it just completely changed it. And I understood it heaps.
* Not real name.

Sienna said her teacher changed the way she felt about mathematics.

**Interviewer:** So do you think the style of teaching you get now has really changed the way you feel about maths?

**Sienna:** Yep, I enjoy it more.

**Interviewer:** Do you think because of that style of teaching you’re going to do better?

**Sienna:** Hopefully (laughs.)

**Interviewer:** You feel a little bit more confident with it?

**Sienna:** Yep, definitely. Like I understand it now. Cause you like revise and practice.

**Interviewer:** Is there anything else about the teaching style that you like? So you’ve said that it goes a bit slower, everything’s broken down and explained, is there anything else?

**Sienna:** Mmm, like if we don’t understand something we’d tell you and you’d like try, kind of try and find a different way to explain it but with Miss Smith it was kind of like repeated again and again, like I didn’t get it the first time so it’s not good the second time.

**Interviewer:** So you quite like the fact that when you ask a question you don’t feel “Oh my god I can’t ask a question” you feel a bit more comfortable asking questions?

**Sienna:** Yep. Many of the students like teachers who explained the concepts well and went back over concepts again.

Many of the Year nine and Year ten girls said the teacher has to be approachable and good with children; they have to have good rapport with the students and be interactive. A friendly atmosphere is important to Alexis.
Alexis

- Good teachers give time for students to understand the concept and have an understanding of where the whole class is at.

Chloe said she likes teachers who do not talk for the whole lesson and give time for discussion and practice. Ava felt a good teacher is enthusiastic and relates to the students. These responses seem to reflect Dorman (2001) and Forgasz and Leder (1998) findings that classroom environment relates positively with academic efficacy and personalisation is critical for females. The senior students thought less about the teacher and more about the content.

Phoebe, however, said that the teacher is a “Deal Breaker”.

**Interviewer:** Sure, absolutely, do you think that teachers make a difference to the way, you’re attitude towards maths or you’re performance in maths?

**Phoebe:** They are probably the deal breaker for me

**Interviewer:** Really

**Phoebe:** Yep um I remember in um, what year was it, I’m gonna say her name because she was fantastic, Miss Fredda*,

**Interviewer:** Yes.

**Phoebe:** Um I had her, I can’t remember what year, it was Year 9 maybe I’d been getting a I think, in previous years when we didn’t have exams or whatever I think I wither failed or got like thirty or forty per cent and I had her and I got like 96 or 98 per cent that year.

**Interviewer:** What was it about her? What was good about her teaching?

**Phoebe:** Well it just well ok um you just knew that she wanted to help you it wasn’t like it wasn’t like she didn’t treat you like a child so if you didn’t
do like it wasn’t like she would come around and check your homework.

**Phoebe:** And the other was like I remember one day it was whether on a weekend or on the holidays or something I just said again it was like year 9 so like you wouldn’t have thought it was a big deal or a big year and I said like emailed her with like I’m just really struggling and she said that’s fine and she said do you want to meet at the library and she caught up with me outside of school and its things like that you just know and it’s like again I was in a young year level and it’s not even VCE and its just knowing that like they care that much as well she was probably the one that made me want to do maths.

* Not real name.

Georgia said she does not ask for help from her teacher as he is unsympathetic. Ruby mentioned a teacher she had in the past would get angry if she asked a question or did not get it straight away. This is significant in the light of Sullivan, Tobias and McDough (2006) and Burton (1995) who said it seems that classroom culture may be an important determinant of under-participation in schooling as students may be turned off studying a subject.

Interesting, strong students Amelia, Charlotte and Chloe said they did not think the teacher and quality of teaching was necessarily that important. Amelia said she likes to learn from the text book and go at her own pace. She just uses the teacher for consolidation or to get clarification. Charlotte said she did not think it matters a “huge amount”. If the class is structured and you know what you have to learn, the teacher is not that important. Chloe said she likes to have the option to work ahead at her own pace and she enjoys a collaborative classroom where she can work with her peers without necessarily involving the teacher supporting Dwerk (1986).
It does not seem to be clear that the teacher is a factor in selection of mathematics subjects (research question 1). While some students indicated the teacher impacted their attitudes and feelings towards mathematics, other suggested the teacher did not have any influence at all. Phoebe was the only student to say the teacher had a direct impact on her decision to continue to study mathematics.

**Do you get anxious about mathematics? What makes you anxious? And how do you go in Test or Exam situations?**

Many were not anxious in general about mathematics, they were more anxious about the rigorous testing that occurs in mathematics. This reflects Hembree (1990) finding that there seems to be two prominent types of anxiety: mathematical anxiety, anxiety about the mathematics itself, and test anxiety, anxiety about the testing procedures of mathematics.

Some students said that when they feel they understand everything, they do not feel anxious.

**Interviewer:** Do you ever get anxious about maths?
**Alexis:** Um, no not really?
**Interviewer:** What about tests?
**Alexis:** Not particularly, because if I do the revision I figure I’ve done as much as I can and I’ll do as well as I can.

Tahlia, Olivia and Sienna all mentioned their anxiety about mathematics comes from the fact that mathematics is so important to them.

**Interviewer:** Is it different to other subjects? Do you stress more about maths than say…
**Tahlia:** Well I think cause it’s generally there’s you’re meant to maths is considered like a more um I don’t know you have higher expectations of doing well in maths and there’s probably more, there’s considered more um important than like general, geography, drama or…something like that. There’s a lot more like expectations and
you if you don’t get it right then it’s kind of big deal. I have to really go over it and get it right.

**Interviewer:** Do you get nervous about doing tests?

**Olivia:** See it depends on which subject I reckon. So like, with history and geography like I did really well in those subjects, but like, it’s not like, I did take them seriously but it wasn’t like really like (laughs) what I wanted to do, but then like the more serious ones like Science or Biology, or Maths that’s when, I don’t know, I get nervous.

**Interviewer:** So we’ve got exams coming up, for example, in three weeks time. Are you more stressed about the maths exams than any other exams or is it the same?

**Sienna:** No, probably more stressed about maths because, I don’t know, I just, I don’t really care that much about ECOS and like some other subjects but I like Maths and Science and I want to do well in them.

Ruby talked about how she becomes anxious if she falls behind in her mathematics work. The timed tests seemed to make Chloe and Emma anxious about tests. Tahlia, Mia and Olivia all mentioned they “freak out”, “go blank” or make silly mistakes in tests. These responses are consistent with the finding that during stress, there is more activity in the amygdala than the prefrontal cortex; decreasing a student’s ability to remember and respond accurately (Ashcraft 2002, Beilock 2008, Legg and Locker 2009, MattarellaMicke, Mateo, Kozak, Foster and Beilock 2011, Millar and Bichsel 2004, Sparks 2007).
Emma and Sophie talked about the stress of social comparison when doing a test.

**Interviewer:** Do you ever get anxious about maths?
**Emma:** Um, yes and no.
**Interviewer:** Tell me about the yes.
**Emma:** Um, tests, it’s like, so if there’s like a booklet of different pages and you hear people moving on and you’re still on the first page that’s really stressful.

**Interviewer:** It sounds like you don’t like the social comparison of tests.
**Emma:** I don’t like that at all.
**Interviewer:** Do you feel like you’re being compared to everybody else and you don’t like that?
**Emma:** Mmm mmm.

**Interviewer:** What is it about tests do you think that makes you anxious?
**Sophie:** I just guess that, cause everyone’s doing the same test as well and if someone’s like a page in front of you I’m like “Oh my god am I slowing down or am I too fast’ Like It kind of just like freaks me out but also because like everyone’s quiet, there’s like no one speaking it’s kind of, I don’t know, it just kind of like scares you (laughs).

These responses support Manger and Eikeland (1997) and Erdogan, Kesici and Sahin (2011) findings that mathematics self-concept and mathematics anxiety can be influenced by the perception social comparison.

Emily and Tamara stress if they feel unprepared or disorganised while Alexis and Charlotte feel less stressed when they feel prepared. Georgia and Sophie do not feel anxious about mathematics and mathematics tests as they do not see the point in learning and being tested on something that they are not going to use later in life reflecting Boaler (1997).
Once again, the strong and average senior student who chose General Mathematics B or Further Mathematics, Ava, Hannah, Amelia and Zoe, expressed little mathematics anxiety while the weak and average students who chose Mathematical Methods, Dana and Phoebe, expressed significant mathematics anxiety. All of the students expressed anxiety around assessment due to the importance placed on the assessment in VCE.

There seems to be a distinct anxiety around the assessment of mathematics at Hilltop College (research question 2). While the weaker students feel mathematics anxiety, the other students seem to have test anxiety based on the importance placed on the subject. With regards to research question 1, anxiety may be a factor for subject selection due to the impact on the students’ decision on whether or not they wanted to submit themselves to the stress that the subject may cause.

Do you see the value of studying mathematics?

The responses to this question were very interesting. Ella, Emma and Charlotte said that it depends on what you want to do after school. If you need mathematics for the profession you were interested in, then it is important. Ava, Dana, Chloe, Georgia, Tamara. Alexis and Mia all said it was important if it is needed to get into a particular course and to “get good jobs”, and it will get you a good ATAR. Tahlia says that you use mathematics everyday so it must be important. She says everyone else said it is important so it must be.

**Intervener:** Really interesting. Um, do you think, you kind or mentioned before, but do you think it’s important to study maths?

**Tahlia:** Yeah.

**Intervener:** Yeah, why is that?

**Tahlia:** Well, I don’t actually, well I guess you use it every day but I think it’s more, everyone else says it’s as important, like maths is just considered important so it’s therefore important. But I think you do use it every day.
Interestingly, Emily and Tamara both said they think studying mathematics is important but they did not know why while Chloe said it is important for her because she likes studying mathematics. In response to research question 1, it was interesting that the girls did not mention the importance of the mathematical sciences due to the high demand of people with advanced analytical and numerical skills, in areas such as banking, commerce, and the manufacturing and engineering sector. The value is placed on the result achieved in the subject and the perception that it will provide entry into a career, not the value of advanced mathematics for application in real life or careers.

What do your parents think?

Families are diverse and independent micro-cultures. And as such, there was a mix of responses to this question. Some students said it was very important to their parents that they do well in mathematics while others said that it was not important.

Tahlia said that her parents think mathematics is very important, but they cannot tell her why. Her mother will not allow her to have her music lessons during a mathematics class. Both Chloe’s parents are very good at mathematics so they would like her to be good at mathematics also. Tamara says her mother thinks it is important even though she is not very good at it while Ella says her mother knows she is not good at mathematics and she would “be ok” if Ella decided not to continue mathematics later. Sienna said her parents value mathematics above any other subject and she must do well in this subject.

Alexis, Sophie and Olivia say their fathers say mathematics is important to get into a course. Amelia talks about how she wished her parents had of had more influence at the end of Year 10.

**Interviewer:** Did your parents have any influence on your decision to do maths this year?

**Amelia:** Um, I wish mine had a bit more at the end of Year 10, because I didn’t choose to do Methods when I should have because I didn’t think about my future when I chose that. So I can’t get into
the course I want to get in now without going through extra pathways. But like they always said maths is a useful subject I think you should keep it and I kind of never really considered dropping it as a subject so, yeah. But they didn’t really have to push me into it.

In response to research question 1, parents’ views as a factor that influence subject selection appears to be unclear. The responses from the students were mixed with some parents saying it was very important to continue studies in mathematics while other parents saying it was more important that the student choose what they like or want to study.

Can you see where mathematics is used in real life?

The girls gave a list of examples where mathematics is used in real life. These include shopping, finance, telling the time, measuring things, business, accounting and economics.

Some of the interesting comments included:

**Interviewer:** That’s really interesting, really interesting. Now you mentioned you know that maths is used every day, what are some situations in real life when maths is used?

**Tahlia:** Um, getting money and getting changed because I picked up on that when people don’t give me the right change, that’s a bit …

**Interviewer:** Anything else?

**Tahlia:** Um, probably don’t register like using maths often but you probably do. But I don’t think I really register what I use maths for.

**Interviewer:** Okay that’s interesting. Can you see where maths is used in real life?

**Chloe:** Not really. No just, just gas, paying for things. But I guess if you’re an Architect?
Interviewer: Can you see anywhere where you’ll use maths in real life?

Georgia: If I go out with friends, like we’ll use like the time and I guess I use it but I don’t notice it, like I thought that’s a square. But I never ever use like algebra or like scientific rotation or …don’t use that.

Interviewer: And can you maths if real life, not necessarily work, but can you see how it would be used in real life?

Alexis: Yeah, everything has a reason and like how to do it. There has to be concept behind it. So, yeah.

Interviewer: Can you see where you’d might use that in real life?

Mia: No.

Interviewer: Not at all? Like is it completely abstract for you?

Mia: Yeah.

Interviewer: So you don’t like that aspect about maths? The fact that it’s not applicable to anything?

Mia: Yeah pretty much. Like there’s like stuff like simple stuff but half the stuff you’re like, like you’re never going to use that in your life.

Interviewer: You can see where you need it?

Olivia: Yeah. So I can, like, you might not want to do it but I think you need the basics of it. Like it helps (laughs).

Interviewer: So you just mentioned shopping, are there any other times that you can see maths in real life?

Olivia: Yeah, I thought, yeah like lots but like I don’t use it (laughs) like a lot, but like um when my Dad’s trying to fix things and he’s like measuring and stuff and he’s like “if I had this and had to take away…”
Interviewer: Do you see where maths is used in real life?

Sophie: Um, yes and no like it’s good in a way that like the times that you do need it like shopping, like ‘oh there’s a discount, what’s that going to be?’ But in like, unless you, like I said, unless you’re going to do something with maths it’s going to be important, but if you’re going to do like Art or something it’s not really necessary. Like it’s good to have but, like I said, I don’t really find it necessary.

It was interesting that many of the girls cited basic mathematics in real life and could not see how the mathematics they learn at school actually is used in real life. Therefore, in response to research question 1, this does not appear to be a factor in the students’ subject selection. There was no mention of advanced analytical and numerical skills, statistics, conceptual understanding and an ability to analyse and solve problems. This may again be a reflection on the way mathematics is taught at Hilltop. The pedagogy is structured and abstract with little attention drawn to the real life applications and uses of mathematics.

Do you know any jobs that use maths?

Again the girls listed some jobs that they were aware of that had a mathematical component. This included: engineering, interior design, accounting, IT, maths teacher, working with computers, health and doctors, vets, architecture, building and investor.

Interviewer: What about jobs, any jobs that have maths in them?

Tahlia: Engineering, and like interial (sic) design. Not really too sure.

Interviewer: Do you know of any jobs that use maths?

Chloe: Architecture, probably Accountants a lot, Financial things, companies, stocks. Yeah and
like I guess, researches, about like and even animals and stuff, exponential things I don’t know where that’s coming from. But I guess it is used a lot.

**Interviewer:** What about jobs, you mentioned Architecture, can you think of any other jobs that need maths in them?

**Ella:** IT person, an Architect, a Maths Teacher. Um I think every job is going to need maths in it somewhere, but the main ones I think are Maths Teachers, and teachers in general, people who are on computers a lot. Yeah that’s mostly it.

**Interviewer:** What about jobs? Do you know of any jobs that use maths?

**Georgia:** Yeah, there’s like health, and like doctors and science and vetted, vets, ahh, I don’t know.

**Interviewer:** Do you think there are any jobs that have maths in them where you actually use maths? Can you think of any?

**Tamara:** I don’t think you need maths to be like a doctor or something, I don’t think you really, I’m not sure how you’d use them except for measurements and things, I’m not sure if you’d use them much.

The girls seem to have very little idea of the many important vocations existing in these modern times that involve some training in mathematics and therefore this does not appear to be a factor in the girls’ subject selection (research question 1).
What subjects are you going to select next year and Why?/ Why did you choose the subjects you did?

The girls’ responses to this question seemed to either reflect the girls’ misunderstanding about what they will study in senior mathematics or it reflected their attitudes towards the subject.

Table 10 - Year 9 Students’ Responses to Subject Selection Question

<table>
<thead>
<tr>
<th>Students’ Response</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tahlia</td>
<td>says she is going to keep Mathematics Methods to Year twelve. She thinks it will be a wasted opportunity if she goes to General/Further Mathematics as she is a capable mathematics student.</td>
</tr>
<tr>
<td>Chloe</td>
<td>thinks she will do both Methods and Specialist Mathematics as she does not like to work in a context and she likes to know exactly what she has to learn.</td>
</tr>
<tr>
<td>Ella</td>
<td>says she thinks she might like to go to General Mathematics as she feels this will be spread over more areas. Emily does not know what she wants to be yet so is not sure. She does, however, know she would like to have to have a basic mathematics at Year twelve.</td>
</tr>
<tr>
<td>Georgia</td>
<td>said a week ago she would have said she would not do any mathematics at Year twelve but now she has changed her mind because she would like to get into university and get a good job so she will probably do the ‘easiest’ mathematics at Year twelve.</td>
</tr>
<tr>
<td>Tamara</td>
<td>said she will do General Mathematics as she feels that this mathematics is “more real life”.</td>
</tr>
</tbody>
</table>

Table 11 - Year 10 Students’ Responses to Subject Selection Question

<table>
<thead>
<tr>
<th>Students’ Response</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexis</td>
<td>said she would like to do Mathematical Methods and maybe Further Mathematics as she will need it for the jobs she would like to do and you use it every day.</td>
</tr>
<tr>
<td>Emma</td>
<td>said she will do Mathematical Methods as it “opens up more doors”. She might do Further Mathematics as well as she is not sure what else she would like to do and she likes it.</td>
</tr>
<tr>
<td>Ruby</td>
<td>said she will do Mathematical Methods even though she does not need it for what she wants to do but she feels it will “open up more doors”.</td>
</tr>
</tbody>
</table>
She feels she would do better at Further Mathematics but it is good to challenge yourself.

**Mia** said she would do both Mathematical Methods and Further Mathematics as her sister did it and she did well. It will also “bump up her scores”.

**Olivia** said she will do Mathematical Methods. She said General Mathematics is good but “you can’t do much with it as it does not lead to any jobs”.

**Charlotte** said she will do Mathematical Methods. She thought about doing Further Mathematics but feels she does not need to. Charlotte also thought Specialist Mathematics would be too hard so while she is probably capable, she has decided to not select the subject to study.

**Sophie** said she will go on to do General Mathematics then Further Mathematics. She said many courses need mathematics and it is “good to have it behind you”.

**Sienna** said she will do Mathematical Methods. She feels she will enjoy that more, even though her sister does Further Mathematics. She prefers mathematics to humanities and it will “help her to get into courses”.

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**Table 12 - Year 11 Students’ Responses to Subject Selection Question**

<table>
<thead>
<tr>
<th>Student</th>
<th>Subject</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ava</strong></td>
<td>General Mathematics</td>
<td>did not have the aspiration to do a course that needed Mathematical Methods. Still wanted a mathematics subject but did not want to subject herself to the hard work required for Methods.</td>
</tr>
<tr>
<td><strong>Dana</strong></td>
<td>Mathematical Methods</td>
<td>middle, not too easy, not too hard. Wanted to challenge herself and Specialist would be too hard.</td>
</tr>
<tr>
<td><strong>Katrina</strong></td>
<td>Both Methods and General Mathematics</td>
<td>does not know what she wants to do and this will “keep options open”. Leaning towards Further next year and not Methods as Methods will take up too much time.</td>
</tr>
<tr>
<td><strong>Hannah</strong></td>
<td>General Mathematics</td>
<td>studying a 3 / 4 subject this year and Methods would be too time-consuming. Teacher last year put her off studying Methods this year.</td>
</tr>
</tbody>
</table>
Table 13 - Year 12 Students’ Responses to Subject Selection Question.

<table>
<thead>
<tr>
<th>Student</th>
<th>Subjectchose and Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amelia</td>
<td>Further Mathematics for Year twelve but wished she had chosen Mathematical Methods as she has cut off her option of applying for Commerce Degrees as most these courses require Mathematical Methods as a prerequisite.</td>
</tr>
<tr>
<td>Zoe</td>
<td>Mathematical Methods initially in Year eleven but changed to General Mathematics halfway through the year. She said she did not need Mathematical Methods to get into the course she wanted and she did not want to have to work as hard as what was required to pass Mathematical Methods.</td>
</tr>
<tr>
<td>Lucy</td>
<td>Further Mathematics as she only needed General Mathematics units 1 and 2 but enjoyed it last year and would give her “something extra” if she chose to study Further Mathematics.</td>
</tr>
<tr>
<td>Phoebe</td>
<td>Mathematical Methods. She continued with “If it was not a prerequisite, I probably would not have done it and probably would have chosen an easier subject”.</td>
</tr>
</tbody>
</table>

These responses seem to reflect Eccles and Jacobs (1986) findings that social and attitudinal factors have a greater influence on enrolment in mathematics courses than do variations in mathematical aptitude. They also reflect Teese (2000) and Brinkworth (1999) suggesting that student only choose a mathematics subject to improve ATAR or to fulfil a university prerequisite. While Crombie et al (2005) found a direct path from competence beliefs to enrolment intentions, some cases in this research suggests the student’s competence belief did not predict the enrolment or enrolment intention as some students were either not achieving at mathematics but still chose the subject or were doing very well but did not select the appropriate pathway for strong mathematics students (research question 1).
Teacher Responses

Mathematics anxiety.

All the teachers agreed there is a culture of mathematics anxiety at Hilltop (research question 2). This anxiety is mostly around tests and other assessments. Margaret said the students always want to know exactly what is on the tests because they did not like taking risks as Dwerk (1986) suggested. Students want a revision sheet that is identical to the test that they will be sitting. Helen agreed saying mathematics anxiety is evident at Hilltop consistently and constantly. She said it was evident at all year levels, all aptitudes and in all mathematics subjects. She said this is evident through the students avoiding mathematics, either by not doing homework or avoiding class altogether.

Michelle believes that much of the anxiety that she sees comes from ill-preparation. This is a focus on the tests and assessment and not the mathematics itself. Michelle cited the students being unwell after tests and high absentee rate on the days tests are scheduled. Interestingly, Margaret mentioned the School Improvement Framework (SIF) that was being conducted at Hilltop at the time of this research project. This program was designed to investigate the processes of the College; however, she said one finding that was reported from the interviews with students, was the evidence of the anxiety around mathematics at Hilltop.

Focus on testing.

When asked about how much testing and assessment is done in mathematics, Margaret said she did not think that there was too much testing. She thought it was important that the students receive frequent feedback. She went on to say that many of the girls always ask exactly what is going to be on the test and they get very anxious about the ‘grade’ they get for mathematics. This calls into question exactly what feedback marks on a test provides; mathematics ability feedback or simply a judgement on a rank or a scale.
Helen, however, disagreed as she felt the girls spent too much time in a testing environment (research question 2). She agreed that the students get very anxious about high stakes testing; however, she said it is important because it gives an indication of the students’ accumulative learning and knowledge needed to prepare the students for the next level. Helen said she believes it is important for the students to feel success in mathematics but she finds it hard to find the right balance between succeeding and challenging.

Helen also agreed that the girls are test-orientated. Questions such as “Is this going to be on the test?” and “Will it be tested this way?” are constantly asked by the students. This shows the culture of Hilltop that they are learning solely for getting good marks on a test (research question 2). They sift out things they feel are “not important” and only focus on what is going to be on the test as Boaler (2002) suggested.

These responses give a clear indication of Hilltops culture of mathematics (research question 2). There seems to be a very strong culture of mathematics and test anxiety from the teachers’ perspectives.

**Difference between males and females in mathematics.**

The teachers all agreed that there is a difference between males and females in their attitudes towards mathematics. Margaret believed that males will have a go at mathematics regardless of their ability level. She said females may be capable but they pull back and are much more cautious. She says she sees this mentality even though there are no males at Hilltop. Helen talked about how the top mathematical students at Hilltop fill the role of males in their absence. The top students have confidence in themselves and their abilities and Helen believes they behave like males would in a co-educational environment. This suggests a hierarchy and dominance that has been observed to be ‘masculine’ and therefore usually favours males (Barnes, 2000, Chapman, 2001, Vale, 2003) is actually displaying by the strong students in the all-female classroom. The other students recede backwards. She believes it does not matter what class it is, these roles are always fulfilled (research question 2).
Helen, however, still believes that the girls at Hilltop still feel inferior to males. When the girls compare themselves to males that the students are acquainted with or other male students from other schools, she believes they do not see themselves as “as good as” the males.

**Helen** They feel quite inferior to the rest of them [the male students]. They don’t feel ‘Hey, I’ve got just as much as a guy.’ I don’t know why but they do feel this real feminine ideal stereotype which is a shame.

Michelle feels the students at Hilltop are very quick to give up and are unable to articulate what they do not understand. She feels males are much better at this. She believes this stems from the cultural belief that females assume they are not good at mathematics and have learnt helplessness; they always ask before even trying.

These responses indicate that maybe there is a subtle gender stereotype present at Hilltop that may not be explicit or noticed by the students. This bias is definitely present in the teachers’ responses to this question. While this responds to research question 2, this may indicate that mathematics is a ‘male domain’ may impact on subject selection in a greater way than initially assumed (research question 1).

**Focus on scores/ATAR/courses.**

In response to research question 1, the teachers believe that a major factor that influences girls’ subject selection of mathematics subjects is the focus on scores, particularly the final ATAR score received at the end of the students’ schooling.

Margaret talked about the high academic standards at Hilltop and how an ATAR of 70 is considered a failure. The girls’ focus is ultimately on achieving a good ATAR score so they choose their subjects accordingly. Margaret noticed the drop in numbers in Mathematical Methods and Specialist Mathematics courses and an increase in Further Mathematics courses. She believes this is because the girls need Chemistry for many of the most desirable courses at university (courses that lead to highly paid or
high status careers). Therefore, they choose to study Chemistry and Further Mathematics because they do not want to study two challenging subjects. Ultimately, a high ATAR is the goal so they think choosing Chemistry as it is a prerequisite and Further Mathematics will give them the best combination of achieving their goal as suggested by Teese (2000). They are strategically choosing their subjects to get the highest ATAR (research question 1).

With such a focus on scores, ATARs and assessment, Helen believes the girls are “thrown off balance, they see the test as more important than the learning”. At the lower levels, the sense that it is important to academically succeed is also present, but on a smaller scale. The students are focused on getting the highest marks. Michelle mentioned that she felt the focus on academics at Hilltop is high. There is pressure to keep up with friends. If the student is not achieving a grade of A, then they feel they are not good enough (research question 2). Michelle talked about a student who is thinking about not continuing into Mathematics Methods because she only achieves a grade of B in mathematics and she feels she is not good enough. Interestingly, Margaret does not believe this happens at Year eleven. As found by Brinkworth (1999), the girls no longer feel pressure from comparing to friends. They feel the pressure from prerequisites and parents, not peers.

**Culture of mathematics at the College.**

The purpose of interviewing the teachers was to get a feel for the culture of Hilltop College and respond to research question 2 regarding the influence of the culture on subject selection. All the teachers articulated they felt Hilltop did have a culture of mathematics anxiety. Margaret also talked about what seems to be a lack of confidence of the girls.

**Margaret**

If they don’t pick it up the first time, they just give up.

She believes this is due to a lack of work ethic and a lack of understanding that sometimes mathematical concepts take time to really understand. Margaret believes the workload is also an issue at Hilltop. The students at the College are very committed to the co-curricular program and
this takes up much of the girls’ time. They have less time to commit to their studies.

Michelle feels there is a culture at Hilltop of girls putting themselves in categories or ranks of mathematics ability. Once the girls find their place in the ranks, they cannot move. They put themselves in the ‘I’m bad at maths basket’ and this cannot be changed. Helen elaborates on this perception by, as mentioned earlier, the ‘good at maths’ girls fulfilling the top rank and the other students feel that they are not part of ‘that culture’. Helen feels that most of the students at Hilltop do not see themselves as mathematicians and she believes this is a problem. Even if there is interaction with other schools (excursions, competitions, etc.) the girls do not see themselves as at the same ability level as the other students. This culture does not manifest good mathematicians (research question 2).

Subject Selection.

As mentioned earlier, Margaret noticed that the numbers for the Further Mathematics classes have risen while the Mathematical Methods and Specialist Mathematics classes have declined. She believes this is due to the students figuring out that Chemistry is a prerequisite for many courses that are desirable and the students do not want to have two challenging subjects in Year twelve. Therefore, they choose Chemistry and Further Mathematics instead or Mathematical Methods. This reflects the students focus on selecting mathematics for the purpose of getting into a course, not because of the value of the subject (research question 1).

Margaret

If they want to get into Nursing or Physiotherapy, it’s better that way.

Margaret suggested weak students often select Mathematical Methods because they have decided to do a university course and they have discovered it is a prerequisite. This often happens midway through or at the end of Year eleven so the student finds they actually do not have the skills to do the work to a high standard. She says they fail to identify what is appropriate for them.
Helen has an interesting perspective on the students’ subject selection. She believes the students choose their mathematics subject for personal reasons. Sometimes it is a small trigger, like an older boy or a brother saying “You don’t need to do so that challenging maths”. She said that subject selection is difficult for students. There is so much information to navigate through that often the parents find some ‘golden advice’ that is not necessarily the best for the student. This is because the parents do not understand the system of VCE and university applications. The most common ‘advice’ is the fact that some subjects get ‘scaled up’. Before the scores of different VCE studies can be added together for the ATAR, they need to be scaled to take account of the different abilities of the students taking different studies (VTAC, 2014) (appendix E).

At Hilltop and many other similar schools (high socioeconomic), the priority of the parents is for the student to achieve the highest possible ATAR. So when they hear that a subject might be ‘scaled up’ (like Mathematical Methods or Specialist Mathematics), they encourage their daughters to study these subjects regardless of ability or interest.

Interestingly, Helen suggests many students at Hilltop choose to study Mathematical Methods or Specialist Mathematics due to the status of mathematical subjects at the College. The students feel that they need to “prove that they can do it”. Prove it to themselves, to their parents and to society. They have chosen a pathway and now they feel they need to stay on it. She said it is confusing for the students at that level; there are so many pathways to navigate so they need a focal point. Often “mathematics is a prerequisite” is that focal point so, for the weaker students, this is an issue (research question 1).

Helen also believes that the students had no idea about how mathematics is used in real life or in careers. She says mathematics is the most abstract subject in secondary school and many students therefore question why would need to study the subject (research question 2).

With regards to the younger students, they have little choice of subjects. Michelle explained the ‘accelerated’ group are selected by invite only. The students need to score very high on the Allwell test (an external
test designed to predict the success of future learning of a student, (glossary, appendix A) to be considered. Therefore, Michelle says many students apply for the group but are rejected. The ‘small group’ is chosen by examining past results and work ethic. Those who are working hard but still need support are selected to go into the small group of only ten students. It is these students who usually go onto the General Mathematics course in Year ten, a modified mathematics program leading the students into General Mathematics B and Further Mathematics in VCE.

The intention of this chapter was to present and discuss the data gathered from the semi-structured interviews of the students and the teachers of Hilltop College and respond to the research questions:

1. What are the factors that influence secondary school girls’ mathematics subject selection?’ and

2. How does the mathematics culture of the school influence these selections?’

It gives an insight into the learning culture of Hilltop in regards to mathematics and the selection of mathematics subjects. Further analysis and implications of these responses will be investigated in the following chapter.
Chapter 5 Analysis

In this chapter, an in-depth analysis will be conducted and conclusions made from the results in the previous chapter. A discussion on how this research adds to the literature will also be incorporated and the implications of the responses will be discussed and analysed. The factors which lead to the students’ subject selection decisions will continue to be examined and more general links will be observed in more detail. Each factor will be explored individually.

Student Responses

Student perception of ‘maleness’ of mathematics.

This interview data within this research supports the findings of Leder and Forgasz (2000) and Francis (2005). While there is still a traditional perception that males are good at mathematics, mathematics is traditionally a male field and females do not like mathematics as much as males do, this dichotomy initially appeared to be somewhat blurred.

When asked if there was a difference between males and females in mathematics, Phoebe, Lucy, Ella, Georgia, Tamara and Sophie all mentioned the men in their families including brothers, fathers and uncles in their responses to the questions. These responses exposed the girls’ thinking that these males are more accomplished at mathematics than they are themselves and therefore their perception that males must be better at mathematics than females. The greatest support for this conclusion comes from Ella, Georgia and Emma saying males were definitely better than females at mathematics; however, they all gave very vague explanations as to why this is the case. Zoe qualified these claims by saying males study Mathematics Methods and females study Further Mathematics. This is despite the student attending Hilltop which is an all-female College and this clearly is not actually the case with several of her fellow students studying Mathematics Methods at Hilltop.

Alexis and Mia indicated they have been told by others that males are better at mathematics than females. Alexis said while she has been told several times that males are better, she could not see it herself. Mia talked about how her Year seven teacher always told the class that males are better
at mathematics than females. She said she was not sure about this claim as she had never seen males do mathematics. This reflects the findings from Brown and Joseph (1999), Shapiro and Williams (2011) and Gunderson et al (2012) that gender attitudes are transmitted from adults to students.

Dana, Amelia, Emma, Ruby, Mia and Olivia made comments suggesting their perceived innate qualities of males are the reason males would and should be better at mathematics than females. Some of the reasons that the girls gave include:

<table>
<thead>
<tr>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight forward thinking</td>
<td>Are more imaginative</td>
</tr>
<tr>
<td>Do it the way they are told</td>
<td>Have open minds</td>
</tr>
<tr>
<td>Mathematics comes naturally</td>
<td>Mathematics does not come naturally</td>
</tr>
<tr>
<td>Are competitive</td>
<td>Are collaborative</td>
</tr>
<tr>
<td>Like mathematics more</td>
<td>Like mathematics less</td>
</tr>
<tr>
<td>Seem better at mathematics</td>
<td>Seem to be not as good at mathematics</td>
</tr>
<tr>
<td>Study Mathematical Methods</td>
<td>Study Further Mathematics</td>
</tr>
</tbody>
</table>

When examining the language the students have used, there is a perception that males are rational and objective and therefore would excel at a subject that is difficult and important while females are emotional and subjective and therefore would find mathematics a challenge.

This shows support for previous literature indicating some females’ construction of the gender dichotomy is still fixed that mathematics is a male domain and therefore they think that females would find it hard to excel or enjoy in the subject (Brandell and Staberg, 2008, Mendick, 2005) or females would find it difficult socially to be good at mathematics (Damarin, 2000) and therefore affecting the girls’ selection of mathematics subjects.

However, some of the responses suggested gender makes no difference to mathematical performance or ability and it depends on the individual’s work ethic as Brinkworth (1999) suggested. Ava, Katrina, Hannah, Chloe, Ella, Alexis, Emma, Olivia, Charlotte and Sienna all said because they attend Hilltop, it is hard to tell the difference between males and females and they seemed to not have a construction of mathematics as a male pursuit. This supports Chazal et al (2012), Cohen (2005) and Van de
Gaer et al (2004) that suggests single-gender classrooms and schools cause the gender stereotypes and differences to fade and may even encourage future mathematics subject selection.

When the students were asked directly as to the reasons for their mathematics subject selections, not one suggested it was because mathematics was a male subject. Therefore, in response to research question 1, the initial impression is while the stereotype does still appear to exist at Hilltop, the dichotomy has blurred with many girls still choosing to study mathematics regardless of the ‘maleness’ of mathematics. This contradicts the findings of Mendick (2005) and Damarin (2000) and supports Frances (2000), Leder and Forgasz, (2000) and Brinkworth (1999) findings. However, a deeper analysis of research question 2 and teachers' responses will be discussed later in this chapter.

**Students’ attitudes and self-efficacy.**

**Students’ attitudes.**

Hyde et al (1990), Forgasz and Leder (1998), Boaler (1997) and Wigfield and Meece (1988) found that females have more negative attitudes towards mathematics. The current research reported this thesis while addressing research question 2 because several of the girls indicated that they do not like studying mathematics or there are several things about mathematics that they do not enjoy. While the literature suggests these negative attitudes impact or influence subject selection (Hyde et al, 1990, Lent, Lopez and Bieschke, 1991), it is the senior students who have selected mathematics subjects to study in Year twelve who commented on their negative attitudes towards the subject. This disagrees with the literature (Thorndike-Christ, 1991). These students all cited other reasons for studying mathematics in Year twelve. The conclusion, in response to research question 1, while having a negative attitude towards mathematics may not affect in full the decision to study mathematics in senior school as there are other, stronger influential factors which will be discussed in more detail later in this chapter, it may, however, have some impact on which particular mathematics subject a student selects.

To come to this conclusion, the language used by some of the students on their responses to what they liked or disliked about mathematics was examined. This included:
The language used emphasises the ‘right or wrong’ nature of the pedagogy of mathematics. Many students feel they have to be right all the time or they feel they have failed. As a consequence, many students have a ‘fear of failure’ attitude towards mathematics, causing frustration or stress if they did not give a correct response to a question or causing a student to not even try a problem due to fear that they may not get the correct answer straight away or at all. It indicates that many students do not like being challenged in mathematics: if it is not understood straight away, it is disliked. This shows support for Dwerk (1986). This also explains why many students indicated they do not like problem solving or analytical questions as these can be very challenging, multi-directional and there may be several possible procedures and solutions.

“I like the that there is a right or wrong answer” – Phoebe
“I don’t like worded questions” - Zoe
“You can get it right or wrong” - Tahlia
“There is way. You learn it and that’s it” - Chloe
“I like short answer, not worded questions. I dislike analytical questions” - Alexis
“Don’t like worded questions or complicated questions in a test” - Ruby
“I like how there is only one way to work out a problem, then you check the answers” - Charlotte
“You’ve got the steps, I like the structure” - Charlotte
“It’s straight forward, only one way to do it” - Katrina
“I hate how sometimes there are many ways to do it” - Katrina

This is indeed an issue as these are the mathematical aspects that need to be developed in students to prepare them for the workforce of the future that will require competence in this area.

While a student may decide to study mathematics in senior school due to other factors, such as it is a prerequisite to a university course, the subject that is chosen may be the General/Further Mathematics pathway due to the perceptions that this pathway is easier, less work and effort is required and it will be less challenging for the student. There is a perception that this pathway will provide more enjoyment and less frustration and stress.

This links to the senior students who mentioned the workload required for the ‘harder’ mathematics subjects. Zoe, Ava and Hannah who did not choose these subjects stated one of the reasons was they wanted to avoid the workload required to succeed in this subject, while Phoebe and Katrina, who did choose the subjects, complained about the considerable workload (research question 1). Georgia, Emma, Mia and Charlotte mentioned how much they disliked the workload required for their Year nine and ten mathematics subjects. This may have an influence on their future subject selections (research question 1).

Curiously, when examining the list of responses above, it was the mathematically strong students, Chloe, Charlotte and Katrina, who commented on how they liked this ‘methodological aspect’ of mathematics. They liked the fact that there was one way to work out a problem, that the subject is structured, that there is only ‘right or wrong’ and one correct answer, that it was straightforward and they liked the formulas of mathematics. It was the aforementioned strong students, and including Alexis, who said they liked short answer type questions and they disliked the worded or analytical problems.

A weaker student, Tamara and a strong student in an accelerated class, Emily, however, cited these reasons for why they disliked the subject. They said they were not good at remembering formulas and ‘stuff’ and there is a lot to remember. While this does highlight the fact that this pedagogy of mathematics may impact the students’ confidence, agreeing with Hyde et al (1990), Thorndike-Christ (1991), Boaler (2002) and Jones et al (1995), this
also emphasises the observation that the way mathematics is taught is an issue.

When examining the language used by the student in their responses to their attitudes towards mathematics, it is clear that the way in which mathematics is taught to these students is impacting on the students attitudes and as a consequence their selection of mathematics in senior school (research question 1).

Memorization, rote learning and skill practice, while still considered important aspects of learning mathematics, are not the only facets. If the teaching of mathematics is solely focussed on these aspects, the impacts can have two major consequences:

1. First, this can cause stress and frustration for a weaker student whose strength may not be memorisation or rote learning. They receive the message that they are unintelligent and incapable at mathematical thinking. However, as discussed previously, mathematical thinking involves so much more including innovation, analytical thinking and problem solving skills. These students may be capable in these areas but will never know as they are never given the opportunity in the classroom to display these important skills. They may therefore never even consider continuing studying mathematics or a career in a mathematical field (research question 1).

2. Second, while strong students may be excellent at memorization, rote learning and skill practice, this is not the only aspects of mathematics. The future workforce will not be looking for people who are capable of remembering procedures or information; they will be looking for innovators, entrepreneurs and people who can think analytically and outside of the square. All students need to be exposed to the type of mathematical thinking required in the future workforce and to give the students an indication of what mathematics can be like in real life situations.

Mathematics needs to become more accessible to all students of the school by moving away from the ‘chalk and talk’ and emphasising of memorisation that only seems to appeal to the stronger students and more towards innovative and interesting pedagogy so students will want to study mathematics, enjoy it more and have more success regardless of ability.
Many students, both weak and strong, commented on the joy they felt when they did understand or got something correct.

The literature suggests females have negative attitudes towards mathematics. This research supports this with most of the students interviewed expressing negativity towards the subject. Even the strong students responded with negative comments when asked how they were going in mathematics this year. This supports Thorndike-Christ (1991) and Boaler (1997) related to confidence in mathematics and a lack of interest mathematics careers. It addresses both research questions suggesting these attitudes may contribute to subject selection and may be part of the culture of Hilltop.

**Students’ self-efficacy.**

Interestingly, while previous literature suggests a link between self-efficacy and subject selection (Lent, Lopez and Bieschke, (1991), Walkington (1998), Crombie et al (2005) in my research this was not always or necessarily the case (research question 1).

Charlotte, Amelia, Zoe and Ava, while achieving very high results, did not believe they were very good at mathematics and therefore did not choose or will not choose Specialists Mathematics or Mathematical Methods. Dana, Olivia and Phoebe, while achieving very poor or average results and being aware of their lack of ability in mathematics still chose to continue with or will choose to continue with Mathematical Methods or Further Mathematics. This contradicts the findings from Lent, Lopez and Bieschke, (1991) that attitudes towards mathematics were predictive of intentions to continue to study mathematics (research question 1).

Phoebe and Dana felt they were not strong at mathematics yet still chose to continue to study the subject. Phoebe used language that indicated her judgment of her abilities. She said

“it’s my bottom subject and I am on track to get what I expected” – Pheobe.

While Dana said:

“I have not been good at maths since day one, I need to work harder at it”. – Dana.
This clearly indicates this student’s perception of her lack of ability in mathematics. Both these students, however, were studying Mathematical Methods in Year twelve and Year eleven respectively.

On the other hand, Ava, Katrina, Hannah, Amelia and Zoe indicated in their responses that they felt they do have a good ability in mathematics; however, all of these students were studying General or Further Mathematics. Katrina said

“I am alright at mathematics but I don’t think I will go on with Mathematical Methods next year”.– Katrina

While Hannah said

“I’m going pretty well. I’m good at basic maths and if I do not have a good teacher, I can teach myself”. – Hannah.

It was difficult to find links between self-efficacy and subject selection from the students at Hilltop (research question 1). Many capable students, who have a strong sense of their ability, did not choose the ‘harder’ mathematics subjects while some weak students, who have a strong sense of their ability, still chose the ‘harder’ mathematics subject.

**Students’ mathematics anxiety.**

From the research, it is clear that some girls feel anxious about mathematics. With further inspection, it is the weaker students that experience anxiety about mathematics itself and the stronger students whose anxiety extends from the importance placed on the subject and the testing involved in the subject. It would seem clear from the discussion below, that, unlike the suggestions of Eccles and Jacobs (1986), Hembree (1990) and Millar and Bischel (2004) that mathematics anxiety is higher in females than males, this research suggests that it has more to do with the ability of the person and the importance they place on mathematics.

The stronger and average students capable of Mathematics Methods but chose General Mathematics B or Further Mathematics, including Ava, Amelia, Zoe and Hannah, did not experience mathematics anxiety while the weaker students and average students studying harder mathematics, including Phoebe, Dana and Katrina, do experience mathematics anxiety. The younger students who said mathematics is important or there is more pressure to well in mathematics, including Tahlia, Chloe, Ella, Emily and
Emma expressed their anxiety about the subject, contradicting Mendick (2005) and Damarin (2000) that it is ‘cool’ to not be good at mathematics. (‘I never want to fail a maths test’) and agreeing with Brinkworth (1999) who found females supportive of those who chose to study mathematics.

Some of the language used included:

**Strong students studying ‘easy’ mathematics:**

“I was anxious in the past, but not this year”. - Ava
“Not this year, the other studies are all consuming”. - Hannah
“Not really”. - Amelia

**Weak students studying ‘hard’ mathematics:**

“Definitely!” - Phoebe
“I don’t know what’s going on so it is stressful” - Dana

**In regards to pressure:**

“Higher expectations, considered more important, so it’s a big deal if you don’t get it right” - Tahlia
“I never want to fail a maths test!” - Ella

The majority of the girls in the research experienced some degree of test anxiety reflecting Felson and Trudeau (1991). This was expressed due to the importance placed on the subject and the unpredictable nature of testing. There was a feeling that something could appear on the test they have not seen before. They felt less anxious if they felt they were prepared for the test. Some disliked the social comparison of standardised testing causing them to be anxious about testing.

“I worry just before the test. I’m worried about what might appear on it” – Chloe
“Nervous about the exam, I know I’m not going to do very well” – Emily
“I get stressed about tests when I don’t understand” – Tamara
“Timing makes me anxious” – Emma
“I hate it when you are stuck in a room and you think ‘What is this?’” – Phoebe
“Test are in complete silence and it’s all (students) at
once” – Dana

“Tests are stressful if getting a good mark is important to you” - Katrina

This reflects Boaler (2002) explaining that motivation is highly situational and the girls are adapting to the environment they are in: that is they are taught to value tests, results and competitiveness.

Mia and Tahlia mentioned the fear of “going blank” or “freaking out” in the test reflecting Ashcraft, (2002), Hembree, (1990), Lyons and Beilock, (2012), Matterella-Micke, Mateo, et al., (2011), Miller and Bichsel, (2004), Beilock, (2008) and Wigfield and Meece, (1988). These studies investigated the phenomenon of students’ ability to access information being impaired in a test situation due to anxiety and how that impacts on the student’s working memory and the ability to acquire the core mathematics and number concepts information.

The girls who expressed they did not experience mathematics anxiety were either doing a mathematics subject below their capabilities (Strong students doing General Mathematics B), weak students who placed no value on the subject with Georgia saying “I’m never going to use this so why am I doing it?” or Ella who has the attitude of “if you do your best, there is nothing more you can do so why get anxious?” In response to research question 1, mathematics and test anxiety are not necessarily very good predictors of mathematics subject selections because while many of the girls at Hilltop do experience a level of anxiety, many still do select to enrol in mathematics subjects.

**Students’ perceptions of real life mathematics and mathematics in the work context.**

The literature reviewed suggests the value placed on mathematics as a factor of that influence girls choice of mathematics as a subject in senior school (Boaler, 1997, Eccles and Jacobs,1986, Meece, Wigfield and Eccles, 1990, and Walkington, 1998). This research suggests that while the girls do value mathematics as a subject, this importance has very little to do with their perceived value of mathematics in real life. While mathematics is valued to gain entry to work in a career, the students’ had little knowledge of how the mathematics is actually applied in these careers.
When the girls were asked if they could see where mathematics is used in real life, every response was either an example of basic arithmetic or no response was given. The girls could see the value of basic mathematics for everyday living, like shopping, measuring, finances, time and direction, but there were no responses that mentioned advanced analytical and numerical skills, statistics, conceptual understanding or an ability to analyse and problem solve, with the exception of Phoebe’s response of:

“I’ve learnt these ridiculous theories to improve logic and improve our ability to understand abstract concepts but I don’t see it day to day” - Phoebe

There is a strong implication that Phoebe’s response suggests that when she, or possibly another student, has inquired as to why she would need to learn complicated and advanced mathematics “these ridiculous theories”, she has been told that mathematics’ main or conceivably only function is for abstract circumstances without any real life examples being given.

The research suggests that the girls appear to have very little idea about the careers that require advanced mathematics. When asked if they knew of any professions that require mathematics, engineering was mentioned by Tahlia, Emma, Charlotte, Sophie, Sienna, Phoebe, Ava, Dana, Hannah and Katrina. Chloe and Alexis mentioned finance careers, such as accounting, business and commerce, and interestingly, Emily, Ella, Phoebe, Ava and Hannah suggested teacher of mathematics. This implies these students only see mathematics in the context of a classroom. The girls were not aware of the number of professions in the growing industries like pharmaceuticals or economics where people with education in higher mathematics are highly sought after. This reflects the culture of mathematics at Hilltop (research question 2) is only focused on mathematics for the sake of mathematics and not its broader applications, particular in careers. This also suggests that, while the girls are aware they need mathematics to enter a desirable career, they would not choose to study a mathematics subject with a view use the mathematics in the future career because they are unaware of careers that apply advanced mathematics (research question 2).
Students’ view of the value of mathematics.

The value that was placed on mathematics by the girls, according to this research, was dependent on whether they thought it was required for entry into university courses.

Many said basic mathematics was important, however, Phoebe suggested it is not important to be good at basic mathematics because of the prevalence of calculators and computers in our society now.

“There is no real need to know or be good at maths now because people have phones and calculators all the time” - Phoebe

Phoebe, Ella, Emma and Charlotte said it depends on what you want to do for a living. They did not think mathematics was important if you were not going to need it for your study path or a profession. Again, this reflects the girls’ awareness that one may need mathematics to enter a career, but they are unaware of exactly how it is applied in that career. In a reflection of the culture of Hilltop (research question 2) Alexis, Emma, Mia, Georgia and Tamara responded that mathematics is important only to gain an advantage in further education such as university courses, to gain a degree, to get a higher ATAR or to “get a good job”.

Interestingly, two younger students both suggested mathematics was important because “everyone else says it is” – Tahlia or “I’ve always been told it is” - Tamara. This shows they themselves do not value mathematics but appreciate there may be some importance as other people, i.e. parents, teachers, say that it is important.

Two quotes that capture the feelings of the students’ value they place on mathematics are:

“I have to be good at it but I don’t get how you are ever going to use it again” – Emily

“Not the ‘crazy’ maths!” – Hannah

The research suggests that, in response to research question 1, mathematics itself is not a factor that influences their subject selection. The perception is that the advanced mathematics is important to “get into” a career but it is not actually used in any careers. The factor that influence
subject selection is the students’ perception of importance of mathematics as a ‘stepping stone’ in a pathway to a desirable outcome; a university course or desirable career.

**The reasons given for subject selection.**

At Hilltop College at this time, what motivates girls to choose mathematics in senior school is entry into university and the perception that this will result in entering employment in a desirable, well-paid profession (research question 1). This is evident when considering Alexis’ response; “I will choose Mathematics Methods because it is used in most jobs and it is what I need’ and Sophie’s response “most courses need maths so it is good to have it behind you”.

The Year nine students’ responses indicated that they did not know a great deal about the senior mathematics subjects. This is evident in the responses given.

“I will do General Maths because it is spread over more areas” - Ella

“I’ll do General Maths because it is more real life” - Tamara

“I am confused about the difference between Further and Specialist” - Chloe

However, the Year nine students seemed to be aware of the importance of mathematics, even if they were not sure exactly the reason or they believed in a link between studying mathematics and working in a desirable occupation.

“I will study Methods. It will be a wasted opportunity if I go to General” - Tahlia

“I like maths out of context so I will probably do both [Mathematical Methods and Specialist Mathematics] as I like to know exactly what I learning” - Chloe

“I don’t know what I want to be so it is important to have maths at Year 12, I need the basics” - Emily

“A week ago no, but now I will study the easiest because I would like to get a job, open opportunities,
get into a good uni course and get a good job”.

Georgia

Every Year ten, Year eleven and Year twelve response to this question, with the exception of one, were related to:

- The opening of opportunities for university or careers,
- The need for mathematics for the University course they hoped to study
- The likelihood that studying mathematics will increase the students’ ATAR score.

The language used includes:
“keep doors open” – Emma – Ruby
“Open job opportunities” – Emily - Georgia
“it will give me something extra” - Lucy
“I will have it behind me” - Sophie
“keep options open” – Phoebe - Katrina
“bump up the scores” - Mia
“It will be a wasted opportunity if I don’t study Maths Methods” - Tahlia
“too much work” - Zoe
“too much time and stress” – Hannah

There was one exception to this trend. Dana responded that she wanted to challenge herself. She thought General Mathematics would be too easy and Specialist Mathematics would be too hard so she chose Mathematical Methods because she wanted to push herself. Interestingly, Dana achieved 33% at the end of Year ten for Mathematics and was not advised to continue with Mathematical Methods into Year eleven. She did say both her parents love mathematics and her father is particularly enthusiastic about mathematics. She said her father has a degree in mathematics and that is why he pushed her into studying the subject.

These responses reflect the culture of Hilltop in regards to mathematics (research question 2). Not one student said they were studying mathematics because they enjoyed the subject or they were genuinely interested in learning more mathematics. This linked with the fact the students did not know where higher mathematics is used in real life or how it is applied in many occupations indicates that the manner in which
mathematics is taught and promoted at Hilltop needs to be reviewed and improved.

**Teachers Responses**

**Teachers’ perceive a focus on assessment and results.**

The reason for interviewing teachers at Hilltop was to gain a sense of the culture of mathematics in the College (research question 2). When examining the language used, a picture appears of the attitudes and feelings around the way mathematics is taught, learnt and perceived.

It is clear from the teachers’ language that Hilltop’s culture of mathematics is centred around the importance placed on assessment and results. The most powerful quote came from Helen agreeing with Burton (1995):

“It is not their fault, it is our fault. What we have made important is the test results and the reports. Certainly society says the ATAR score is what they have been taught is important. We have programmed them: institutions, family and society”. – Helen

This perspective has developed a culture of only studying mathematics for the sake of gaining a good result or completing a prerequisite. It is consistent with the analysis of the students’ responses: only enrol in mathematics because it “opens doors” or “bumps up scores”. The students do not have a love for mathematics or an interest in the subject.

“Learning is solely for getting marks of a test”. – Helen

There is a culture of ‘those who can do’ and ‘those who can’t do’ mathematics. Michelle mentioned how the students categorise themselves into ‘baskets’, the ‘I’m good at maths’ basket and the ‘I’m bad at maths’ basket. The top performing students are in a ‘maths culture’ that the other students feel alienated from. The students do not ‘see themselves as mathematicians’, they do not fit into that foreign culture and therefore cannot connect or embrace mathematics as anything other than a subject as a means to an end. The purpose of studying mathematics is to complete a prerequisite for a university course (research question 1).
The teachers’ language perpetuates this idea.

“Well, I suppose at the end of the day, they’re trying to get the highest possible ATAR aren’t they?” (by strategically choosing their subjects) – Margaret

Helen mentions the way Hilltop and the parents need to understand ‘the system’ referring to the way subjects are chosen with particular attention to prerequisites and the way some subjects are ‘scaled up’ or ‘scaled down’ (see Appendix E). This emphasises Hilltop’s culture of only choosing mathematics because it may be ‘scaled up’ or it is a prerequisite reflecting Teese (2000) suggestion of strategic selection (research question 2).

This culture of focussing on assessment and results may be perpetuated by the teachers’ attitudes towards testing. Margaret and Helen both justify why testing is so prevalent at Hilltop.

“We do test frequently but we give feedback frequently”. – Margaret

“High stakes testing has to be done to show the accumulation of knowledge and the preparedness of the girls to go onto the next level”, – Helen

Helen does go on to admit that it is not good for the students to be under test conditions so often. The inference here is that Hilltop is aware that this strategy is not necessarily the most effective for the students but maybe it is too difficult or too time consuming to change.

Another interesting comment from Helen was that often teachers will go on a path of teaching mathematics for interest sake but will be “pulled into line” by the assessment, reflecting the emphasis on tests instead of the joy of mathematics (research question 2).

“I was preparing my girls saying, you have got to use π as an exact value, and teaching them about how important it is to be in exact values and getting them use to the idea of 3.1π — 3 in Year 8 so that they were comfortable with that being the length. We worked on that the whole time. Got the test and the test says correct to 2 decimal places and use π as 3.142 and you’re like woooow, do you know what I mean? So what’s happening
is what you’re trying to instil and suddenly the test doesn’t match up with what you’ve tried to focus on and what you’ve tried to instil in them so, ok, it is a type of energy saving thing what happens then is four out of five classes haven’t been taught that way so if I was writing my own test every time, I would have a different focus. The girls say ‘2 decimal places is that enough? No, that’s not enough accuracy.” – Helen

“The girls get off balance because they then see the test is more important than the learning.” – Helen

**Teachers’ view if the status of mathematics.**

While many students and teachers cannot articulate the reasons, studying mathematics is held in very high regard at Hilltop. This is because it can be challenging, it is a prerequisite for many university courses and societies perception that if one very clever if one is capable of studying mathematics. Therefore, within Hilltop’s culture, enrolling in mathematics holds status (research question 2). From the top students “rolling their eyes” at the weaker (and often older) students who are unable to grasp a concept quickly, to the ratio of strong to weak students in a class “impacting of the dynamic of the classroom”, those ‘who can’ are held in high esteem by their peers. Michelle refers to the “pressure to get As if your friends are” and Helen even refers to the weaker students addressing the stronger students with the words ‘All Hail’ insinuating their level of rank and power. At this age (adolescence), the students’ strongest relationship is with their peers; therefore having status among their peers is paramount (Black, Deveroux and Kjell, 2013). The students are aware that they are also being compared to students all over the state thus making this status position crucial.

Due to the culture of the high status of mathematics, many students enrol in mathematics to prove that they can ‘do it’ (research questions 1 and 2).

“Prove it to themselves, prove it to their parents and prove it to society.” – Helen

Again, this contradicts Mendick (2005) and Damarin (2000) findings that it is ‘fashionable’ to not be good at mathematics and being good at mathematics is undesirable. It agrees with Brinkworth (1999) who found
there was no peer pressure through labelling or stigmatism of those who studied mathematics.

The teachers suggest that the status of mathematics at Hilltop is why many students make inappropriate subject selections in the later years of school (research question 1). Both Margaret and Helen mentioned weak students choose to study ‘harder’ mathematics due to the status of the subject. Whether it is because it is a prerequisite for desirable and acceptable university courses (acceptable meaning courses leading to highly paid or high status careers), or one must be seen to be studying the ‘hard’ mathematics, many students choose to enrol in mathematics because it has status.

Strong students study ‘easy’ mathematics or no mathematics because they are gaining status by studying another ‘hard’ subject, such as Chemistry or Latin, and therefore do not need to study two challenging subjects.

The teachers talked about Hilltop’s grouping of mathematics subjects from Year nine (selecting students to enrol in the ‘small group’, the ‘mainstream group’ or the ‘accelerated group’ appendix A). The fact that this is not done with any other subject also emphasises Hilltop’s culture around the status of mathematics (research question 2). Michelle talked about how at Year nine, several girls are chosen to enrol in the ‘small group’; referring to the weaker students in a small class of about ten students. These students are on a track to stay in the small group in Year ten, enrol in General Mathematics B in Year eleven and then Further Mathematics or not to study mathematics at all in Year twelve. There is also an ‘accelerated group’ chosen from an external test and previous results. The status of mathematics at Hilltop is such that even if the student does not like or want to be accelerated at this stage, in Year nine, it is considered necessary or important to ‘be in the top group’ if you wish to be considered ‘smart’ or ‘clever’. This is emphasised by Michelle when she said many girls applied for this group, even if ‘unqualified’, with over half of the applicants being ‘rejected’. This process is often initiated by the parents and their perception of the importance of mathematics. Interestingly, Michelle said that teachers were not asked for input for appropriate students to be selected. This reinforces Hilltop’s culture of focussing on results and marks
and not on the other important aspects of learning and achievement like critical or analytical thinking (research question 2).

On the other hand, there are some strong students who do not feel this pressure to study a subject with status. Helen suggests they do not choose the subject because of ‘pure laziness; the idea of the least possible work to gain the most’ and so they will not enrol in a mathematics subject. This agrees with Teese (2000) and is consistent with many of the students’ responses of “I don’t need it so why would I work really hard and jeopardise my other, more important, subjects?” This gives an insight into the attitude of some at Hilltop that consider students capable of studying harder mathematics but choose not to are labelled ‘lazy’ indicating that some students may perceive this and chose an inappropriate subject to avoid being given that label (research question 2).

Teachers’ perception of gender issues.

Interestingly, while many of the students did not feel there was any gender bias or inequality at Hilltop, with further analysis of the teachers’ language, there appears to be a subtle bias towards the greater ability and connection with mathematics of males.

When asked about the difference between males and females and the experience of working at Hilltop, all the teachers gave their opinion favouring males.

“Boys would have a go no matter what. Even boys who are not good at maths, they insist on doing Methods.” – Margaret

When referring to the top students status and behaviour in a class:

“It’s like a ‘boy thing’. Boys are more confident in themselves, as they should be.” – Helen

“It seems to be our boys are the accelerated ones.” – Helen

“Boys are much better at articulating what they don’t understand while girls put their hand up and say “I don’t get it” and hit a wall much quicker.” – Michelle

“I think it’s a cultural thing, girls assume they are not as good at maths. I’m not sure.” – Michelle
While these quotes are possibly just a reflection of the wider society, this is what the students are exposed to on a daily base. The subtle or hidden messages of gender bias in mathematics influences the girls’ connection and feelings about mathematics and where they place themselves in the culture of mathematics (research question 2). This reinforces the finding of Shapiro and Williams (2011) that being female and interacting with someone who holds a negative stereotype can result in continually being explicitly reminded of a gender stereotype. This may explain Helen suggesting that even her top students feel “inferior to other schools, particularly the boys. They feel inferior to the boys’ feminine ideal stereotype” (research question 2).

**Teachers’ perception of parental influence.**

Some of the students talked about the influence and impact of their parents had on their subject selection of mathematics. The language the teachers used supports this influence suggesting parents do indeed influence many of the students at Hilltop.

“By Year 11, they are no longer following their friends, but rather their parents and prerequisites.” – Margaret

Helen goes on to put this in perspective. Due to the parents investing in their daughters’ education, the culture of many of them is to focus on their daughters getting the highest possible marks, instead of focusing on the best educational experience. Therefore the parents need to manoeuvre through a lot of information regarding VCE and university entrance. This can be overwhelming or simply too much information so they hold onto advice or small understandable pieces of information which may not be necessarily sound. This includes mathematics being ‘scaled up’ or it is a prerequisite to many desirable courses. This means parents place importance on mathematics and then “put pressure on their daughters to do well in this subject”.

Michelle emphasises the importance parents put on mathematics when she said the students tend to improve in her classes after parent/teacher interviews. Many of the girls do not want to study mathematics, however, they are told by their parents “you will study mathematics and that’s it!”
Teachers’ perception of mathematics and test anxiety.

Hilltop has a very strong culture of mathematics anxiety (research question 2). This can be captured in Helen’s response to the question regarding anxiety.

“Absolutely! You can see it consistently and constantly at all year levels, all aptitudes and in all subjects of mathematics.” – Helen

All the teachers explain the behaviours that are displayed to show the girls are anxious including absenteeism, particularly when tests are scheduled, teachers described students going home after tests ill and parents calling explaining the anxiety their daughters are experiencing.

“I receive feedback from parents saying their daughter is having a meltdown regarding the test.” – Michelle

Examination of the teachers and students responses surrounding the anxiety of mathematics at Hilltop appears to be a combination of all the elements that make up this culture (research question 2).

Importance and high stakes are put on the assessment and testing at Hilltop. The fact that this is more important than the mathematics itself, the learning of mathematics and the lack of connection with mathematics courses the students to be anxious.

There is also an importance placed on the subject by teachers, parents and society. The fact that it is a common prerequisite for university courses increases its importance. Parent’s perception of mathematics is it must be studied in secondary school in order to be selected into a university course. This then flows onto teachers who “need to get their scores in their classes up” so more of the students from Hilltop get high results and therefore there will be a high number of students accepted into university.

“I encourage my girls and say ‘If you can just get through it, it leaves a lot of doors open.” – Michelle

There is the status placed on mathematics at Hilltop. The ‘cans’ and the ‘cannots’ label can affect one’s own self-belief and value. Students feel they must be good at mathematics or they are stupid, out of the ‘group’ or not worthy. They need to “prove it” and this courses anxiety. This is
perpetuated by the segmenting of students in mathematics but not in any other subjects at Hilltop. ‘Small group’, ‘mainstream’ or ‘accelerated’ – what ‘basket’ does the student belong to?

When students choose subjects that are inappropriate, it can impact on anxiety. Students try to study a subject that is beyond their capabilities because they feel they ‘have to.’

Finally, there is the conflict students feel being female enrolling in or being good at a ‘male’ subject. While many students stated they did not feel this, the subtle message that ‘males are better at mathematics than females’ may cause tension within a student.

Summary of Analysis

After investigating and analysing the responses to the interview questions, there are several factors that influence girls to select mathematics subjects in secondary school. It is clear that mathematics subjects have a high status at Hilltop College and this status impacts on the girls’ selection of these subjects. Due to the culture of frequent and high stakes testing and importance placed on results, particularly at Year twelve, mathematics and test anxiety are prominent. The ‘can dos’ and the ‘cannot dos’ culture of mathematics also contributes to the mathematics and test anxiety. This anxiety can cause some students to circumvent mathematics to avoid being exposed to that anxiety. While the students did not explicitly express a stereotype bias in regards to mathematics, there does appear to be a subtle bias which can be impacting on the girls’ selections. The students expressed negative attitudes towards mathematics, however, there are more influential factors impacting on selection. The major factor that appears to influence girls’ decision to enrol in a particular subject is its value as a prerequisite for many desirable university courses or to gain a higher ATAR score.
Chapter 6 Conclusions and Implications

Research methods using semi-structured interviews proved to be an effective way to gather data on the factors that influence girls’ mathematics subject selection in secondary school. The interview questions covered the many factors identified through the literature review to be possible influences on the reasons the number of girls enrolling in mathematics course, particularly advanced mathematics, and the number of females in mathematical careers is low and still lower than males. Qualitative methods were used to explore the factors and to collect deep and intricate data from fewer participants. By exploring the discourse and narratives of participates rather than numerical data, there was a freedom that was created for the students and teachers to express themselves in their own words.

Many realities have been created through participants own perceptions of the situation. Participant reality is the convergence between the experienced and the felt. When listening to the narratives of the participants, the context of their situation is paramount. These narratives are influenced and shaped by the cultural ambiences; they set the guidelines in which the narratives are communicated. As the cultural influence on the girls’ subject choices was focused on, qualitative methods proved to be an appropriate method to use to research this topic.

Research Findings

In response to the research question ‘What are the factors that influence secondary school girls’ mathematics subject selection’, this research has produced findings which both reinforce previous research and highlight new perspectives.

There are limited discipline issues at Hilltop and there is a very strong focus on academic success. Success for this College is the attainment of university entrance. From the data collected and the language used by the girls in the study, the major influence on the students’ subject selection was both an increased ATAR score and mathematics as a prerequisite for desired university courses, not because is it interesting or required for a career. By this ‘door-opener’ definition Hilltop’s mathematics program is a success. However, it fails to spark the students’ intellectual passions. Mathematics is seen as a peripheral to their learner selves. It is not embodied. They are mere students of mathematics rather than budding or
engaged mathematicians. It is something that is done not something to become.

While the students’ were aware of the stereotype that ‘mathematics is a male domain’, there was very little evidence that this belief impacted the students’ subject selection. However, after further investigation into the culture of the College via the teachers’ responses, there are both blatant and subversive gender biases at play that the students are not explicitly aware of but could be impacting their attitudes and therefore their subject selection decisions.

Also contributing to the negative attitudes towards mathematics at the College is the anxiety the students feel in regards to the subject. While the literature revealed overwhelming evidence that mathematics anxiety impacted on girls’ choice to continue to study mathematics, this research suggests that mathematics subjects are chosen despite the anxiety felt by the students. They chose the subject because they thought they ‘had to’. There is also suggests that students indicated that they specifically chose a particular mathematics subject to avoid the mathematics anxiety. The exploration into the culture at Hilltop revealed mathematics to have a high status.

The high status of mathematics at Hilltop causes students anxiety and many students experience a dreaded anxiousness towards testing and assessment. This is caused by the importance and high stakes put on the assessment and testing at the College. This has developed a culture of working at mathematics for the sake of gaining a good result on an assessment or completing a prerequisite, not for an interest or love of the subject itself.

One of the most interesting findings from this research was the fact that the students had very little idea of the transferability and applicability of the mathematics to everyday and workforce. With many students unable to articulate how mathematics is impacting the workforce in these modern times, it makes sense that the girls will not select mathematics for interest or for career opportunities. Therefore this had very little influence on their subject selection.
This research also revealed that the teaching of mathematics can influence the attitudes and feelings about mathematics, however, this had little impact of subject selection, while self-efficacy and confidence influences the type of mathematics chosen. Weaker students continued to study mathematics, but commonly chose an ‘easier’ mathematics subject.

**Limitations**

There were some limitations with the research conducted.

- The researcher was the Year Level Coordinator of Year ten at Hilltop at the time the research was being conducted. This means the students were very familiar to the researcher. Likewise, the researcher may have been or was at the time the mathematics teacher of some students that were interviewed. This may have caused some students to not be comfortable sharing information as they may not be convinced of privacy. On the other hand, some may share information quite readily as the researcher was familiar to them. Another obstacle to the students knowing the researcher quite well was they may have tried to please and say what they think the researcher wanted to hear instead of what is authentic to them. As mentioned in chapter 3, efforts were made to curb the effects of this by reassuring the student participants that their responses were to gather data for a research project and would have no effect on their results or future subject selection.

- The use of qualitative methods resulted in fewer subjects, therefore not as much data was gathered as other methods. As this study was conducted over a short time, it resulted in taking a ‘snapshot’ of the factors at one time which means they could be tentative as these factors and decisions can change over time.

- This research has investigated the factors that influence the girls from Hilltop and is therefore realised that students from different types of schools may produce different results. Hence, it would be beneficial to extend the research to include co-educational schools, independent schools and government secondary schools.

- The number of enrolments in advanced mathematics indicates there is a decline in the number of males as well as females, therefore further research
into investigating the factors that influence males also would also be valuable.

**Transferability**

As mentioned earlier, qualitative research is a ‘snapshot’ of the culture and attitudes of the particular College at this particular time. These results, however, may reflect young females’ interaction with and attitudes towards mathematics in a wider context. Many other educational institutions have similar pressures and contexts as Hilltop College. Other high socio-economic status schools with high fee structures have similar expectations of academic success and the results from this research may provide some insight into the attitudes of the females at these schools.

The issues raised in this research may also give clues into what to look for in other research settings. It may give a guide to the themes that can be pursued and questions to ask when preparing survey or interview questions. As the methodology of this research is transferable to other settings, this research may give ideas into how to structure a similar project in a different situation and location.

**Implications of the research**

**Pedagogy.**

The research findings identify a need for pedagogical transformation at Hilltop. Further research into the way mathematics is taught in secondary school need to be investigated. Mathematics needs to be made more appealing for the students of this College by moving away from the traditional pedagogies, colloquially referred to as ‘chalk and talk’ type of teaching that only seems to appeal to the strong students and move towards innovative and engaging pedagogy so students will want to study the subject. Solely working out of a text book keeps mathematics in the abstract realm instead allowing mathematics to come alive for the students. Analysis activities, problem solving and mathematics in the real world need to be a permanent fixture of the mathematics curriculum.
By making mathematics applicable and engaging for the students, they will be more likely to connect with the subject and want to study it. Not only because they feel it is necessary to increase their ATAR score or to get into university, but in response to genuine interest and an understanding of the importance of mathematics.

Different methods of assessment also need to be included in mathematics programs. Shifting the emphasis from ‘getting the answer right’ to the process or many responses being acceptable will remove the test anxiety that is so prevalent at the College. While it is important that students are prepared for the rigours of examinations they will face in late senior school, it is crucial the students are exposed to the many important facets of mathematics that are valued as equally as accuracy. Assessment on, and rewards for, innovation, analysing, communication and problem solving will not only give all students an opportunity to succeed but will prepare them for real world mathematics.

These findings have informed changes in the researcher’s planning and teaching of mathematics. The researcher has begun to implement strategies to address the findings from the research. These strategies include:

- Handing back test papers without any marks written on them, only feedback on errors for the students to correct and learn from.
- Allowing the students to re-sit tests to demonstrate learning and emphasize that gaining of knowledge as important, not the mark on the test.
- Incorporating real world examples of the mathematics being studied, taking learning outside the classroom and beyond the College gates to see mathematics in action.
- Setting tasks where the solution is given and marks are only awarded for process and communication.
- Lessons dedicated to a worded/analytical/real life mathematics problem.
- Encouraging and even rewarding questions, suggestions and discussions while learning about mathematical concepts (no question is stupid/there are never too many questions).
Promotion of mathematics.

If universities do not have mathematics, particularly advanced mathematics, as prerequisites for courses then student numbers may decline further. Therefore, there needs to be an emphasis on the importance of mathematics to support future innovations for Australia’s prosperity. There needs to be more prominence given to careers that are now emerging and the mathematical skills required for those professions. There also needs to be a greater link between the mathematics taught in school and the real world.

The researcher has started to invite female guest speakers from industries such as Engineering, Australian Defence Force, Aeronautics and Astrophysics to speak to the students at Hilltop about the numerous careers and opportunities available for students who excel or indeed study mathematics at an advanced level. With this exposure at school level, the students will have a greater awareness of how important mathematics is in the modern workforce, and may spark the interest of some to pursue these careers.

Mathematics needs to be more than just a stepping stone. Females need to connect with the subject and recognise its value for more than just a course prerequisite. This connection will have a flow on effect of greater numbers of females enrolling in all mathematics subjects. With stronger students enrolling in the more advanced subjects, they will go on to train and work in the emerging fields in this modern workforce.

With a change in pedagogy and the positive promotion of its value, mathematics may be perceived as a genuine subject of worth and interest instead of ‘If you can just get through it, it leaves a lot of doors open.’
References


Köller, O., Baumert, J., & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in


## APPENDIX A

### Glossary of terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>AAE / Accelerated Group</td>
<td>Accelerated Analysis Extension. The accelerated mathematics program at Hilltop College. Strong students in Year 9 have an option to enrol in an accelerated class. The program consists of the Year 10 curriculum and analysis problems.</td>
</tr>
<tr>
<td>Allwell Test</td>
<td>The Allwell Test is an external test designed to identify intellectual strengths and weaknesses in Written Expression, Mathematics, Reading Comprehension and General Abilities. The aim of this test is to assess both curriculum related mathematics as well as mathematical reasoning (problem solving). Approximately 45 minutes for 60 questions</td>
</tr>
<tr>
<td>ATAR</td>
<td>Australian Tertiary Admission Rank. The rank given to the majority of students in Victoria that successfully complete the Victorian Education Certificate used to gain entry into tertiary education.</td>
</tr>
<tr>
<td>SIF</td>
<td>School Improvement Framework. A process undertaken by Hilltop Girls’ College to examine the processes of the College and make recommendations for improvement.</td>
</tr>
<tr>
<td>Small Group</td>
<td>The name given to the mathematics group that is designed to support weaker mathematics students. Only a maximum of 10 students are in the class at any time.</td>
</tr>
<tr>
<td>VCAA</td>
<td>Victorian Curriculum Assessment Authority. The VCAA is an independent statutory body responsible for providing high quality curriculum, assessment and reporting that enables individual lifelong learning.</td>
</tr>
<tr>
<td>VCE</td>
<td>Victorian Education Certificate. The Victorian Certificate of Education (VCE) is the certificate that the majority of students in Victoria receive on satisfactory completion of their secondary education. The VCE provides diverse pathways to further study or training at university or TAFE and to employment.</td>
</tr>
<tr>
<td>VTAC</td>
<td>Victorian Tertiary Admissions Centre. The central office that administers the application processes for places in tertiary courses, scholarships and special entry access schemes at university, TAFE and independent tertiary colleges in Victoria (and a few outside Victoria). VTAC receives and forwards application information and supporting documentation to the relevant authorities at institutions.</td>
</tr>
<tr>
<td>3 and 4 subject</td>
<td>Unit 3 and Unit 4 of a Victorian Education Certificate subject usually completed in Year 12 but can be taken in Year 11.</td>
</tr>
</tbody>
</table>
APPENDIX B

Ethics – Plain Language Statements and Consent Forms

Plain Language Statement - Principal of the College

A/Prof Robyn Pierce (Supervisor)

Melbourne Graduate School of Education
ph: 8344 8519

Ms Robyne Clyne (Master of Education candidate)
ph. 8862 1000


I would like to ask for permission for your school to participate in the above research project, which is being conducted by A/Prof Robyn Pierce (Supervisor) and Ms Robyne Clyne (Master of Education candidate) of the Melbourne Graduate School of Education at The University of Melbourne. This project will form part of Ms Clyne’s Master’s thesis, and has been approved by a University of Melbourne Human Research Ethics Committee.

Due to the importance of mathematics for the new occupations for the technological world and the under representation of girls in higher mathematics courses at school and university, the aim of the study is to investigate factors influencing girls’ selection of mathematics subjects. Should you agree to allow participation, a careful selection of Year 8 to Year 12 students will be asked to participate in a focus group or an interview. They will be asked to respond to several questions regarding their attitudes towards mathematics including pedagogy, assessment, subject selection and the perception of their own abilities. The focus groups and interview would be audio-recorded so that we can ensure that we make an accurate record of what is said. We estimate that the total time commitment required for the students would not exceed 90 minutes.

In addition a selection of teachers will also be asked to participate in interviews where they will be asked to reflect both on students’ mathematics subject selections and the factors that they perceive influence these choices.

We intend to protect the participants’ anonymity and the confidentiality of their responses to the fullest possible extent, within the limits of the law. Participants’ names and contact details will be kept in a password-protected computer file separate from any data
supplied. This will only be able to be linked to responses by the researchers, for example, in order to know where to send interview transcripts for checking.

In the final report, the participants will be referred to by a pseudonym. We will remove any references to personal information that might allow someone to guess the students identity, however, you should note that as the number of people we seek to interview is very small, it is possible that someone may still be able to identify a student.

Once the thesis arising from this research has been completed, a brief summary of the findings will be available to the school. It is also possible that the results will be presented at academic conferences. The data will be kept securely for five years from the date of publication, before being destroyed.

Please be advised that all participation in this study is completely voluntary. Should a participant wish to withdraw at any stage, or to withdraw any unprocessed data supplied, they are free to do so without prejudice.

If you agree the school participating in this study, please indicate that you have read and understood this information by signing the accompanying consent form and returning it in the envelope provided.

Should you require any further information, or have any concerns, please do not hesitate to contact either of the researchers; A/Prof Pierce: 8344 8519 or Ms Clyne: 8862 1000. Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

Regards,
Robyne Clyne
Master of Education Candidate
Melbourne Graduate School of Education
Consent form Principal of the College.


Name of School: Genazzano FCJ College

Name of investigators: A/Prof Robyn Pierce and Ms Robyne Clyne Melbourne Graduate School of Education

1. I give my consent for Genazzano FCJ College to participate in the project named above, including participation of students and teachers in focus groups and participation in interviews, the particulars of which have been explained to me. A written copy of the information has been given to me to keep.

2. I authorise the researchers to use the responses from the focus groups and Interviews for the purpose of research.

3. I acknowledge that:
   (a) the requirements of the students and teachers participating in the focus groups and interviews have been explained to me to my satisfaction;
   
   (b) I have been informed that the students and teachers are free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied;
   
   (c) the project is for the purpose of research;
   
   (d) I have been informed that the confidentiality of the information the students and teachers provide will be safeguarded subject to any legal requirements;
   
   (e) I have given consent for interviews to be audio-taped;
   
   (f) copies of transcripts will be returned to the students and teachers for verification;
   
   (g) the students and teachers will be referred to by pseudonyms in any publications arising from the research;
   
   (h) students will be informed that participation or non-participation in the research will have no effect on their assessment or future subject selection.

Principal Signature ___________________________ Date: _______
Plain Language Statement – Student Participants

A/Prof Robyn Pierce (Supervisor)
Melbourne Graduate School of Education
ph: 8344 8519

Ms Robyne Clyne (Master of Education candidate)
ph: 8862 1000


Introduction

Due to the importance of mathematics for the new occupations for the technological world and the under representation of girls in higher mathematics courses at school and university, the aim of the study is to investigate factors influencing girls’ selection of mathematics subjects. As someone who must make choices regarding the study of more mathematics subjects, we would like to invite you to participate in our research project. This project has been approved by a University of Melbourne Human Research Ethics Committee.

What will I be asked to do?

Should you agree to participate, you would be asked to participate in either a focus group or interview. The focus group will consist of about 10 participants from students in Year 8 to students in Year 12 who will be asked to respond to several questions regarding their attitudes towards mathematics including teaching, processes, subject selection and the perception of their own abilities. With your permission, the focus group would be audio-recorded so that we can ensure that we make an accurate record of what is said. When the recording has been transcribed, you would be provided with a copy of the transcript, so that you can verify that the information is correct and/or request changes. The interview will cover similar issues but allow more opportunity for individuals to talk about their experiences.

We estimate that the total time commitment required of you throughout the project would not exceed 60 minutes.

How will my confidentiality be protected?

We intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. Your name and contact details will be kept in a password-protected computer file, separate from any data that you supply. This will only be able to be linked to your responses by the researchers, for example, in order to know where we should send your interview transcript for checking. In the final report, you will be referred to by a pseudonym. We will remove any references to personal information that might allow someone to guess your identity; however, you should note that as the number of people we seek to interview is small, it is possible that someone may still be able to identify you.
The data will be kept secure for five years from the date of publication, before being destroyed.

**How will I receive feedback?**

Once the thesis arising from this research has been completed, a brief summary of the findings will be available to you on application. It is also possible that the results will be published or presented at academic conferences.

**Will participation prejudice me in any way?**

Please be advised that your participation in this study is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice. Your decision to participate or not, or to withdraw, will not affect your assessment in mathematics or other subjects.

**Where can I get further information?**

Should you require any further information, or have any concerns, please do not hesitate to contact either of the researchers on the numbers given above. Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

**How do I agree to participate?**

If you are willing to participate, please indicate that you have read and understood this information by signing the accompanying consent form. The researchers will then contact you to arrange a mutually convenient time for you to participate in the focus group.

Regards,
Robyne Clyne
Master of Education Candidate
Melbourne Graduate School of Education
Consent Form – Student Participants


Name of participant: __________________________________________________________

Name of investigators: A/Prof Robyn Pierce and Ms Robyne Clyne
Melbourne Graduate School of Education

1. I consent to participate in the project named above, including participation in a focus group/participation in an interview, the particulars of which have been explained to me. A written copy of the information has been given to me to keep.

2. I authorise the researcher or assistant to use the responses from the focus group/Interview for the purpose of research.

3. I acknowledge that:
(a) the details of the focus group/interview have been explained to me to my satisfaction;

(b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied;

(c) the project is for the purpose of research;

(d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements;

(e) I have given consent to interviews being audio-taped;

(f) copies of transcripts will be returned to me for verification;

(g) I will be referred to by pseudonym in any publications arising from the research;

(h) participation or non-participation in the research will have no effect on my assessment or subject selections.

Participant Signature __________________________ Date: __________

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Plain Language Statement Teacher Participants

A/Prof Robyn Pierce (Supervisor)
Melbourne Graduate School of Education
ph: 8344 8519

Ms Robyne Clyne (Master of Education candidate)
ph. 8862 1000


Introduction

Due to the importance of mathematics for the new occupations for the technological world and the under representation of girls in higher mathematics courses at school and university, the aim of the study is to investigate factors influencing girls’ selection of mathematics subjects. This project has been approved by a University of Melbourne Human Research Ethics Committee.

What will I be asked to do?

Should you agree to participate, you would be asked to participate in an interview during which you will be asked to reflect on factors you see as influencing mathematics subject selection. With your permission, the interview would be audio-recorded so that we can ensure that we make an accurate record of what you say. When the recording has been transcribed, you would be provided with a copy of the transcript, so that you can verify that the information is correct and/or request changes. We estimate that the total time commitment required of you throughout the project would not exceed 90 minutes.

How will my confidentiality be protected?

We intend to protect your anonymity and the confidentiality of your responses to the fullest possible extent, within the limits of the law. Your name and contact details will be kept in a password-protected computer file, separate from any data that you supply. This will only be able to be linked to your responses by the researchers, for example, in order to know where we should send your interview transcript for checking. In the final report, you will be referred to by a pseudonym. We will remove any references to personal information that might allow someone to guess your identity; however, you should note that as the number of people we seek to interview is small, it is possible that someone may still be able to identify you. The data will be kept secure for five years from the date of publication, before being destroyed.

How will I receive feedback?
Once the thesis arising from this research has been completed, a brief summary of the findings will be available to you on application. It is also possible that the results will be published or presented at academic conferences.

**Will participation prejudice me in any way?**

Please be advised that your participation in this study is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice.

**Where can I get further information?**

Should you require any further information, or have any concerns, please do not hesitate to contact either of the researchers on the numbers given above. Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

**How do I agree to participate?**

If you are willing to participate, please indicate that you have read and understood this information by signing the accompanying consent form. The researchers will then contact you to arrange a mutually convenient time for you to participate in the focus group.

Regards,
Robyne Clyne
Master of Education candidate
Melbourne Graduate School of Education
Consent Form – Teacher Participants


Name of participant: __________________________________________________

Name of investigators: A/Prof Robyn Pierce and Ms Robyne Clyne
Melbourne Graduate School of Education

1. I consent to participate in the project named above, including participation in an interview, the particulars of which have been explained to me. A written copy of the information has been given to me to keep.

2. I authorise the researcher or assistant to use the responses from interview for the purpose of research.

3. I acknowledge that:
   (a) the details of the interview have been explained to me to my satisfaction;

   (b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied;

   (c) the project is for the purpose of research;

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements;

   (e) I have given consent to interviews being audio-recorded;

   (f) copies of transcripts will be returned to me for verification;

   (g) I will be referred to by pseudonym in any publications arising from the research

Teacher Signature _________________________ Date: __________
Plain Language Statement – Parents of Participants

A/Prof Robyn Pierce (Supervisor)
Melbourne Graduate School of Education
ph: 8344 8519

Ms Robyne Clyne (Master of Education candidate)
ph. 8862 1000


I would like to ask for permission for your daughter to participate in the above research project, which is being conducted by A/Prof Robyn Pierce (Supervisor) and Ms Robyne Clyne (Master of Education candidate) of the Melbourne Graduate School of Education at The University of Melbourne. This project will form part of Ms Clyne’s Master’s thesis, and has been approved by a University of Melbourne Human Research Ethics Committee.

Due to the importance of mathematics for the new occupations for the technological world and the under representation of girls in higher mathematics courses at school and university, the aim of the study is to investigate factors influencing girls’ selection of mathematics subjects. Should you agree to allow participation, your daughter will be asked to participate in a focus group or an interview. She will be asked to respond to several questions regarding her attitudes towards mathematics including pedagogy, assessment, subject selection and the perception of your own abilities. The focus groups and interview would be audio-recorded so that we can ensure that we make an accurate record of what is said. We estimate that the total time commitment required for your daughter would not exceed 90 minutes.

We intend to protect your daughter’s anonymity and the confidentiality of their responses to the fullest possible extent, within the limits of the law. Your daughter’s name and contact details will be kept in a separate, password-protected computer file from any data supplied. This will only be able to be linked to responses by the researchers, for example, in order to know where to send interview transcripts for checking. In the final report, your daughter will be referred to by a pseudonym. We will remove any references to personal information that might allow someone to guess your daughter’s identity, however, you should note that as the number of people we seek to interview is very small, it is possible that someone may still be able to identify her.

Once the thesis arising from this research has been completed, a brief summary of the findings will be available to the school. It is also
possible that the results will be presented at academic conferences. The data will be kept securely for five years from the date of publication, before being destroyed.

Please be advised that your daughter’s participation in this study is completely voluntary. Should she wish to withdraw at any stage, or to withdraw any unprocessed data supplied, she is free to do so without prejudice. These choices will have no impact on assessment or future subject selections.

If you agree to your daughter participating in this project, please indicate that you have read and understood this information by signing the accompanying consent form and returning it in the envelope provided.

Should you require any further information, or have any concerns, please do not hesitate to contact either of the researchers; A/Prof Pierce: 8344 8519 or Ms Clyne: 8862 1000. Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

Regards,
Robyne Clyne
Master of Education candidate
Melbourne Graduate School of Education
Consent Form – Parent of Participants


Name of participant: ____________________________________________________________

Name of investigators: A/Prof Robyn Pierce and Ms Robyne Clyne
Melbourne Graduate School of Education

1. I give my consent for my daughter to participate in the project named above, including participation in focus groups and participation in interviews, the particulars of which have been explained to me. A written copy of the information has been given to me to keep.

2. I authorise the researcher or assistant to use the responses of my daughter from the focus groups and interviews for the purpose of research.

3. I acknowledge that:
   (a) the details of the focus groups and interviews have been explained to me to my satisfaction;

   (b) I have been informed that my daughter is free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied;

   (c) the project is for the purpose of research;

   (d) I have been informed that the confidentiality of the information my daughter provides will be safeguarded subject to any legal requirements;

   (e) I have given consent for interviews to be audio-taped;

   (f) copies of transcripts will be returned to my daughter for verification;

   (g) my daughter will be referred to by pseudonym in any publications arising from the research;

   (h) participation or non-participation in the research will have no effect on my daughter’s assessment or future subject selections.

Parent Signature __________________________ Date: __________
APPENDIX C

Letter of Attestation

This letter of attestation is in relation to the inquiry audit of Masters of Education thesis entitled: The Factors that Influence Secondary School Girls’ Mathematics Subject Selections.

The purpose of this audit is to review research products maintained by the thesis author to establish the accuracy of the records. The notion of an inquiry audit is based on the concepts underpinning a fiscal audit where an impartial agent examines records, checking both the method of bookkeeping and the accuracy of financial statements. In this instance the inquiry audit focuses on the content of the data records themselves. The process was carried out at the conclusion of the research.

The following text was used as the main references for carrying out the audit: Lincoln, Y. S. & Guba, E. G. (1985), Naturalistic Inquiry. Beverly Hills: Sage (with particular reference to pages 317 – 327)

Building on Cronbach and Suppes’ (1969) notion that disciplined inquiry is inquiry that is open to inspection and verification, Lincoln and Guba (1985) advocate that the role of the auditor is to make the inspection and verification on behalf of the reader and to attest to having done so.

The Audit Procedure

The audit procedure involved

- Outlining the structure of the audit trail and the substance of the audit trail.
- Checking the accuracy of the transcripts against the audit tapes and checking written quotations in the thesis against transcripts.

To do this, checks were made on the correspondence between the interview recordings and the transcripts and the confirmability of references to data in the results and analysis chapters.
Accuracy of Interviews in Relation to interview recordings

The focus was on checking the accuracy of the transcripts of the recorded interviews. Five interviews were chosen at random from the 25 available. The auditor listened to the interviews in their entirety.

Specifically the auditor requested:

- Interview – Year 9 Tahlia
- Interview – Year 10 Emma
- Interview – Year 10 Mia
- Interview – Year 11 Ava
- Interview – Teacher Margaret

These extracts were found to be very accurate.

Accuracy of Quotations in Relation to Data Sources

15 quotations were chosen randomly from various parts of the thesis and were checked against the original data records. Sources included the mathematics results of the students from Hilltop Girls’ College’s data base and interview material from the 25 recordings.

Specifically the auditor chose:

<table>
<thead>
<tr>
<th>Page no. in thesis</th>
<th>Source</th>
<th>Page no. in source document</th>
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</thead>
<tbody>
<tr>
<td>Page 52</td>
<td>Interview - Year 10 Ruby</td>
<td>Page 1</td>
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<tr>
<td>Page 56</td>
<td>Interview – Year 10 Mia</td>
<td>Page 4 - 5</td>
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<td>Page 57</td>
<td>Interview – Year 9 Tahlia</td>
<td>Page 1 - 2</td>
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<td>Page 58</td>
<td>Interview – Year 10 Sienna</td>
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<td>Page 61</td>
<td>Interview – Year 10 Alexis</td>
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<td>Page 62</td>
<td>Interview – Year 10 Olivia</td>
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<td>Page 65</td>
<td>Interview – Year 12 Amelia</td>
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<td>Interview – Teacher Helen</td>
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<td>Page 93</td>
<td>Interview – Year 9 Georgia</td>
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<td>Page 94</td>
<td>Interview – Teacher Helen</td>
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<td>Page 96</td>
<td>Interview – Teacher Margaret</td>
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The above citations within the test were cross-referenced with original sources and were found to be very accurate. Pseudonyms have been used to fulfil ethical demands of theses.

Consequently I, as auditor, testify that the transcripts and citations which I have examined in relation to Robyne Clyne’s thesis true and accurate.

Mrs Marilyne Wallace
APPENDIX D

Subject Summaries

STUDY SUMMARY

MATHEMATICS 2006–2015

The accreditation period for VCE Mathematics has been extended until 31 December 2015.

Please Note: This study summary comprises excerpts from the VCE Mathematics Study Design. The summary is not a substitute for the VCE Study Design. Users are advised to consult the VCAA website (www.vcaa.vic.edu.au/Pages/vce/studies/mathematics/foundation/foundmathindex.aspx) to view the full accredited Study Design and other resources.

Rationale

Mathematics is the study of function and pattern in number, logic, space and structure. It provides both a framework for thinking and a means of symbolic communication that is powerful, logical, concise and precise. It also provides a means by which people can understand and manage their environment. Essential mathematical activities include calculating and computing, abstracting, conjecturing, proving, applying, investigating, modelling, and problem posing and solving.

This study is designed to provide access to worthwhile and challenging mathematical learning in a way which takes into account the needs and aspirations of a wide range of students. It is also designed to promote students’ awareness of the importance of mathematics in everyday life in a technological society, and confidence in making effective use of mathematical ideas, techniques and processes.
Structure

The study is made up of 12 units:

Units 1 and 2:  Foundation Mathematics
   General Mathematics
   Mathematical Methods Computer Algebra System (CAS)
Units 3 and 4:  Further Mathematics
   Mathematical Methods (CAS)
   Specialist Mathematics

Each unit contains between two and four areas of study.

Entry

There are no prerequisites for entry to Foundation Mathematics Units 1 and 2, General Mathematics Units 1 and 2 or Mathematical Methods (CAS) Units 1 and 2. However, students attempting Mathematical Methods (CAS) are expected to have a sound background in number, algebra, function, and probability. Some additional preparatory work will be advisable for any student who is undertaking Mathematical Methods (CAS) Unit 2 without completing Mathematical Methods (CAS) Unit 1.

Students must undertake Unit 3 of a study before entering Unit 4 of that study.

Enrolment in Specialist Mathematics Units 3 and 4 assumes a current enrolment in, or previous completion of, Mathematical Methods (CAS) Units 3 and 4.

Units 1 to 4 are designed to a standard equivalent to the final two years of secondary education.

Units 1 and 2: Foundation Mathematics

Foundation Mathematics provides for the continuing mathematical development of students entering VCE, who need mathematical skills to support their other VCE subjects, including VET studies, and who do not intend to undertake Unit 3 and 4 studies in VCE Mathematics in the following year. Provision of this course is intended to complement General Mathematics and Mathematical Methods (CAS). It is specifically designed for those students who are not provided for in these two courses. Students
completing this course would need to undertake further mathematical study in order to attempt Further Mathematics Units 3 and 4.

In Foundation Mathematics there is a strong emphasis on using mathematics in practical contexts relating to everyday life, recreation, work and study. Students are encouraged to use appropriate technology in all areas of their study. These units will be especially useful for students undertaking VET studies.

The areas of study for Units 1 and 2 of Foundation Mathematics are ‘Space, shape and design’, ‘Patterns and number’, ‘Handling data’ and ‘Measurement’.

At the end of Unit 1, students will be expected to have covered material equivalent to two areas of study. All areas of study will be completed over the two units. Unit 2 can be used to complement Unit 1 in development of the course material. Some courses may be based on the completion of an area of study in its entirety before proceeding to other areas of study. Other courses may consist of an ongoing treatment of all areas of study throughout Units 1 and 2. It is likely that a contextual approach will lead to the development of implementations that draw on material from all areas of study in each semester.

**Units 1 and 2: General Mathematics**

General Mathematics provides courses of study for a broad range of students and may be implemented in a number of ways. Some students will not study Mathematics beyond Units 1 and 2, while others will intend to study Further Mathematics Units 3 and 4. Others will also be studying Mathematics Methods (CAS) Units 1 and 2 and intend to study Mathematical Methods (CAS) Units 3 and 4 and, in some cases, Specialist Mathematics Units 3 and 4 as well. The areas of study for Unit 1 and Unit 2 of General Mathematics are ‘Arithmetic’, ‘Data analysis and simulation’, ‘Algebra’, ‘Graphs of linear and non-linear relations’, ‘Decision and business mathematics’ and ‘Geometry and trigonometry’.

Units 1 and 2 are to be constructed to suit the range of students entering the study by selecting material from the six areas of study using the following rules:

- for each unit, material covers four or more topics selected from at least three different areas of study;
• courses intended to provide preparation for study at the Units 3 and 4 level should include selection of material from areas of study which provide a suitable background for these studies;

• selected material from an area of study provide a clear progression in key knowledge and key skills from Unit 1 to Unit 2.

The appropriate use of technology to support and develop the teaching and learning of mathematics is to be incorporated throughout the course. This will include the use of some of the following technologies for various areas of study or topics: graphics calculators, spreadsheets, graphing packages, dynamic geometry systems, statistical analysis systems, and computer algebra systems.

**Units 1 and 2: Mathematical Methods (CAS)**

**Unit 1**

Mathematical Methods (CAS) Units 1 and 2 are designed as preparation for Mathematical Methods (CAS) Units 3 and 4. The areas of study for Unit 1 are ‘Functions and graphs’, ‘Algebra’, ‘Rates of change and calculus’ and ‘Probability’. At the end of Unit 1, students will be expected to have covered the material outlined in each area of study given below, with the exception of ‘Algebra’ which should be seen as extending across Units 1 and 2. This material should be presented so that there is a balanced and progressive development of skills and knowledge from each of the four areas of study with connections among and across the areas of study being developed consistently throughout both Units 1 and 2.

Students are expected to be able to apply techniques, routines and processes involving rational and real arithmetic, algebraic manipulation, equation solving, graph sketching, differentiation and integration with and without the use of technology, as applicable. Students should be familiar with relevant mental and by hand approaches in simple cases.

The appropriate use of computer algebra system (CAS) technology to support and develop the teaching and learning of mathematics, and in related assessments, is to be incorporated throughout the unit. Other technologies such as spreadsheets, dynamic geometry or statistical analysis software may also be used, as appropriate, for various topics from within the areas of study for the course.
Familiarity with determining the equation of a straight line from combinations of sufficient information about points on the line or the gradient of the line and familiarity with Pythagoras’ theorem and its application to finding the distance between two points is assumed. Students should also be familiar with quadratic and exponential functions, algebra and graphs, and basic concepts of probability.

Unit 2

The areas of study for Unit 2 are ‘Functions and graphs’, ‘Algebra’, ‘Rates of change and calculus’, and ‘Probability’. At the end of Unit 2, students will be expected to have covered the material outlined in each area of study. Material from the ‘Functions and graphs’, ‘Algebra’, ‘Rates of change and calculus’, and ‘Probability’ areas of study should be organised so that there is a clear progression of skills and knowledge from Unit 1 to Unit 2 in each area of study.

Students are expected to be able to apply techniques, routines and processes involving rational and real arithmetic, algebraic manipulation, equation solving, graph sketching, differentiation and integration with and without the use of technology, as applicable. Students should be familiar with relevant mental and by hand approaches in simple cases.

The appropriate use of computer algebra system (CAS) technology to support and develop the teaching and learning of mathematics, and in related assessments, is to be incorporated throughout the unit. Other technologies such as spreadsheets, dynamic geometry or statistical analysis software may also be used, as appropriate, for various topics from within the areas of study for the course.

Units 3 and 4: Further Mathematics

Further Mathematics consists of a compulsory core area of study ‘Data analysis’ and then a selection of three from six modules in the ‘Applications’ area of study. Unit 3 comprises the ‘Data analysis’ area of study which incorporates a statistical application task, and one of the selected modules from the ‘Applications’ area of study. Unit 4 comprises the two other selected modules from the ‘Applications’ area of study.

Assumed knowledge and skills for the ‘Data analysis’ area of study are contained in the topics: Univariate data, Bivariate data, Linear graphs and
modelling, and Linear relations and equations from General Mathematics Units 1 and 2.

The appropriate use of technology to support and develop the teaching and learning of mathematics is to be incorporated throughout the units. This will include the use of some of the following technologies for various areas of study or topics: graphics calculators, spreadsheets, graphing packages, statistical analysis systems, dynamic geometry systems, and computer algebra systems. In particular, students are encouraged to use graphics or CAS calculators, computer algebra systems, spreadsheets or statistical software in ‘Data analysis’, dynamic geometry systems in ‘Geometry and trigonometry’ and graphics calculators, graphing packages or computer algebra systems in the remaining areas of study, both in the learning of new material and the application of this material in a variety of different contexts.

Units 3 and 4: Mathematical Methods (CAS)

Mathematical Methods (CAS) Units 3 and 4 consists of the following areas of study: ‘Functions and graphs’, ‘Calculus’, ‘Algebra’ and ‘Probability’, which must be covered in progression from Unit 3 to Unit 4, with an appropriate selection of content for each of Unit 3 and Unit 4. Assumed knowledge and skills for Mathematical Methods (CAS) Units 3 and 4 are contained in Mathematical Methods Units (CAS) Units 1 and 2, and will be drawn on, as applicable in the development of related content from the areas of study, and key knowledge and skills for the outcomes of Mathematical Methods (CAS) Units 3 and 4.

In Unit 3, a study of Mathematical Methods (CAS) would typically include a selection of content from the areas of study ‘Functions and graphs’, ‘Algebra’ and applications of derivatives and differentiation, and identifying and analysing key features of the functions and their graphs from the ‘Calculus’ area of study. In Unit 4, this selection would typically consist of remaining content from the areas of study: ‘Functions and graphs’, ‘Calculus’, ‘Algebra’ and the study of random variables and discrete and continuous probability distributions and their applications. For Unit 4, the content from the ‘Calculus’ area of study would be likely to include the treatment of anti-differentiation, integration, the relation between integration and the area of regions specified by lines or curves described by the rules of functions, and simple applications of this content.
The selection of content from the areas of study should be constructed so that there is a development in the complexity and sophistication of problem types and mathematical processes used (modelling, transformations, graph sketching and equation solving) in application to contexts related to these areas of study. There should be a clear progression of skills and knowledge from Unit 3 to Unit 4 in each area of study.

Students are expected to be able to apply techniques, routines and processes involving rational and real arithmetic, algebraic manipulation, equation solving, graph sketching, differentiation and integration with and without the use of technology, as applicable. Students should be familiar with relevant mental and by hand approaches in simple cases.

The appropriate use of computer algebra system technology (CAS) to support and develop the teaching and learning of mathematics, and in related assessments, is to be incorporated throughout the course. This will include the use of computer algebra technology to assist in the development of mathematical ideas and concepts, the application of specific techniques and processes to produce required results and its use as a tool for systematic analysis in investigative, problem-solving and modelling work. Other technologies such as spreadsheets, dynamic geometry systems or statistical analysis systems may also be used as appropriate for various topics from within the areas of study.

Units 3 and 4: Specialist Mathematics

Specialist Mathematics consists of the following areas of study: ‘Functions, relations and graphs’, ‘Algebra’, ‘Calculus’, ‘Vectors’ and ‘Mechanics’. The development of course content should highlight mathematical structure and proof. All of this material must be covered in progression from Unit 3 to Unit 4, with an appropriate selection of content for each of Unit 3 and Unit 4. The selection of materials for Unit 3 and Unit 4 should be constructed so that there is a balanced and progressive development of knowledge and skills with connections among the areas of study being developed as appropriate across Unit 3 and Unit 4. Specialist Mathematics Units 3 and 4 assumes concurrent or previous study of Mathematical Methods (CAS) Units 3 and 4. They contain assumed knowledge and skills for Specialist Mathematics, which will be drawn on as applicable in the development of content from the areas of study and key knowledge and skills for the outcomes.
In Unit 3 a study of Specialist Mathematics would typically include content from ‘Functions, relations and graphs’ and a selection of material from the ‘Algebra’, ‘Calculus’ and ‘Vectors’ areas of study. In Unit 4 this selection would typically consist of the remaining content from the ‘Algebra’, ‘Calculus’, and ‘Vectors’ areas of study and the content from the ‘Mechanics’ area of study.

Students are expected to be able to apply techniques, routines and processes, involving rational, real and complex arithmetic, algebraic manipulation, diagrams and geometric constructions, solving equations, graph sketching, differentiation and integration related to the areas of study, as applicable, both with and without the use of technology. The appropriate use of technology to support and develop the teaching and learning of mathematics is to be incorporated throughout the units. This will include the use of some of the following technologies for various areas of study or topics: graphics calculators, spreadsheets, graphing packages, dynamic geometry systems and computer algebra systems. In particular, students are encouraged to use graphics calculators and other technologies both in the learning of new material and the application of this material in a variety of different contexts.

Familiarity with sequence and series notation and related simple applications, the use of sine and cosine rules in non-right-angled triangles and the following mathematics is assumed:

• the solution of triangles in two-dimensional situations;
• the sum of the interior angles of a triangle is 180°;
• the sum of the exterior angles of a convex polygon is 360°;
• corresponding angles of lines cut by a transversal are equal if, and only if, the lines are parallel;
• alternate angles of lines cut by a transversal are equal if, and only if, the lines are parallel;
• opposite angles of a parallelogram are equal;
• opposite sides of a parallelogram are equal in length;
• the base angles of an isosceles triangle are equal;
• the line joining the vertex to the midpoint of the base of an isosceles triangle is perpendicular to the base;
• the perpendicular bisector of the base of an isosceles triangle passes through the opposite vertex;
• the angle subtended by an arc at the centre of a circle is twice the angle subtended by the same arc at the circumference;
• the angle in a semicircle is a right angle;
• angles in the same segment of a circle are equal;
• the sum of the opposite angles of a cyclic quadrilateral is 180°;
• an exterior angle of a cyclic quadrilateral and the interior opposite angle are equal;
• the two tangents to a circle from an exterior point are equal in length;
• a tangent to a circle is perpendicular to the radius to the point of contact;
• the angle between a tangent to a circle and a chord through the point of contact is equal to the angle in the alternate segment.

Assessment

Satisfactory Completion

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated achievement of the set of outcomes specified for the unit. This decision will be based on the teacher’s assessment of the student’s performance on assessment tasks designated for the unit.

Levels of Achievement

Units 1 and 2

Procedures for the assessment of levels of achievement in Units 1 and 2 are a matter for school decision.

Units 3 and 4

The Victorian Curriculum and Assessment Authority will supervise the assessment of all students undertaking Units 3 and 4. In the study of VCE Mathematics students’ level of achievement will be determined by School-assessed Coursework and two end-of-year examinations.

Percentage contributions to the study score in VCE Mathematics are as follows:

Further Mathematics

• Unit 3 School-assessed Coursework: 20 per cent
• Unit 4 School-assessed Coursework: 14 per cent
• Units 3 and 4 examination 1: 33 per cent
• Units 3 and 4 examination 2: 33 per cent.

**Mathematical Methods (CAS)**

• Unit 3 School-assessed Coursework: 20 per cent
• Unit 4 School-assessed Coursework: 14 per cent
• Units 3 and 4 examination 1: 22 per cent
• Units 3 and 4 examination 2: 44 per cent.

**Specialist Mathematics**

• Unit 3 School-assessed Coursework: 14 per cent
• Unit 4 School-assessed Coursework: 20 per cent
• Units 3 and 4 examination 1: 22 per cent
• Units 3 and 4 examination 2: 44 per cent.

APPENDIX E

Scaling and the Australian Tertiary Admission Rank

In calculating study scores, the VCAA does not determine any measure of overall performance in the VCE, but rather the performance of each student in each individual study. In order to facilitate selection, institutions require an overall measure of the performance of students undertaking the VCE in all studies.

Before the scores of different VCE studies can be added together for the ATAR, they need to be scaled to take account of the different abilities of the students taking different studies.

The study score is not a score out of 50. It is a ranking or relative position which shows a student’s performance compared with all other students who took that study in that year. A student with a study score of 30 is in the middle of the cohort, or has performed better than about half of all students. A student with a study score of 40 has performed better than about 91% of all students who did that study.

What this means is that the middle student in any study will have a study score of 30, regardless of how strong the other students were in the study and how difficult it was to achieve the middle ranking. This does not mean that some studies are inherently more difficult than others. In fact, most are designed to be of equal difficulty. However, the stronger the competition, the harder it is to achieve the middle score of 30.

So all study scores are scaled by VTAC before they are used to calculate the ATAR. Scaling adjusts the study scores in each study to take account of the strength of competition among students taking the study. The strength of competition in each study is measured by how well the students in that study performed in their other studies. The study scores are scaled so that the overall level of scores in that study matches the scores obtained by the same group of students in all of their other studies combined.

Once the study scores have been scaled, they are called scaled scores. It is the scaled scores that are used to calculate the ATAR. VCE studies are always scaled in the year in which they were undertaken (this may not necessarily be in the year in which you receive your ATAR).
By using scaled scores, fair comparisons can be made of students’ achievements over all their studies, regardless of the studies they have taken.

Because of this, students can freely choose studies they like or are good at without worrying about their ATAR.

This is not always well understood and many students believe that to achieve their best possible ATAR they need to choose studies that are scaled up. This is not true and may even work against you. Every year there are many students who achieve high scaled scores for studies that have been scaled down, and achieve lower scaled scores for studies that have been scaled up.

If you choose a study that you are not very good at simply because it will be scaled up, the study score you receive will be a lot lower than what you could expect in a study you are good at and that interests you. While your score will be scaled up, it is unlikely that your scaled score would be any higher than if you had chosen a more suitable study, even one that is scaled down.

The way to ensure that you achieve your best ATAR is to choose your studies according to what you are interested in; what you are good at; and what studies you need for future study.

The calculation of the ATAR guarantees that all studies are treated equally and provides you with a common score for tertiary selection across Australia.

Studies with additional scaling

Mathematics

VCE Mathematics studies are designed to cater for students of differing abilities and interests. Specialist Mathematics is the most difficult, followed by Mathematical Methods (CAS) and then by Further Mathematics.

To ensure that students undertaking the more difficult mathematics studies are not disadvantaged, all three mathematics studies are scaled against each other as well as being scaled against all other studies. The higher of the two resulting scales is used.

Languages
As a result of government policy to encourage the study of languages, a further adjustment is made during the **scaling** process. Each VCE Language is adjusted up by adding five to the initial scaled score average. All students of a VCE Language receive an adjustment, but it is not a uniform adjustment. For study scores at or close to 30, the adjustment is 5, but the adjustment decreases as the study score moves away from 30.

Transcript of interview – MIA

**Interviewer:** So how do you think you’re going so far in maths this year?

**Mia:** Um, alright.

**Interviewer:** Yeah, what makes you say that?

**Mia:** There’s just some things are coming together than others, but got to work hard.

**Interviewer:** What aspects are you doing well in?

**Mia:** Um, I like doing the simple stuff like shapes and area and stuff like that. I hate quadratics.

**Interviewer:** What about them do you hate?

**Mia:** There’s just so much working out and there’re really confusing.

**Interviewer:** What do you think makes them confusing?

**Mia:** There’s a lot to know and a lot to remember.

**Interviewer:** A lot of steps?

**Mia:** Yeah.

**Interviewer:** And you don’t like the steps?

**Mia:** Not really.

**Interviewer:** Can you see where you’d might use that in real life?

**Mia:** No.

**Interviewer:** Not at all? Like is it completely abstract for you?

**Mia:** Yeah.
Interviewer: So you don’t like that aspect about maths? The fact that it’s not applicable to anything?

Mia: Yeah pretty much. Like there’s like stuff like simple stuff but half the stuff you’re like, like you’re never going to use that in your life.

Interviewer: Can you think of any jobs or situations where you might use maths? Like if there are any jobs that have maths in it?

Mia: A Maths Teacher.

Interviewer: Maths Teacher, yes. Anything else?

Mia: An Accountant, um, a Maths some person of some kind. I don’t know. Ah yeah.

Interviewer: Nothing else?

Mia: No.

Interviewer: So getting a job with maths in it is not something you’re really thinking about?

Mia: Well, like obviously everything has maths in it but like not all that quadratics and all that stuff.

Interviewer: The abstract stuff.

Mia: Yeah.

Interviewer: Where do you think you’re heading, do you think you’ll do something that needs maths?

Mia: I have no idea, probably.

Interviewer: So what makes maths enjoyable for you?

Mia: Um, just when you get something.

Interviewer: Get a sense of achievement, satisfaction when you actually understand it?

Mia: Yeah.
Interviewer: Anything else you like about it?

Mia: Um…ah when you get something, I don’t know, when you get something right, I guess.

Interviewer: Is there anything that you really dislike about it, what do you hate about maths?

Mia: The workload. Sometimes you just, and like how I only have a day or something to do it, it’s like sometimes it just…

Interviewer: It’s too much?

Mia: Yeah.

Interviewer: Do you feel like you commit a lot of time to homework, to doing maths homework?

Mia: It depends like what it is, like with something I was more confident with I did it in like half an hour with more difficult stuff it takes like an hour.

Interviewer: And it takes up a lot of your time?

Mia: Yeah.

Interviewer: And you don’t like that?

Mia: No.

Interviewer: Do you think the teachers make a difference in your maths ability or achievement or how much you like it?

Mia: Yeah massively. I had a really bad teacher last year and um I’ve got a better teacher and…

Interviewer: What made the teacher last year bad for you?

Mia: She was really like, like she spoke so fast and then we’d ask her, we’d tell her we didn’t understand something and she’d just say “Just keep listening” or something like that she didn’t actually go back and explain so…

Interviewer: And how did that make you feel? Bit frustrated?
Mia: Yeah, massively.

Interviewer: And therefore you didn’t enjoy going to the class? Is that right?

Mia: Yep.

Interviewer: What about the teacher this year do you actually like? What are some of the things that make you like going to maths?

Mia: Um, teacher’s really good. Um like, like you go back and explain lots and um, like you won’t move on until everyone completely 100% understands it which is really good. And yeah you do lots of examples and then you send the notes and then like everyone it’s very relaxed so everyone ‘s able to learn the way that’s most comfortable for them.

Interviewer: So does that make you enjoy, you may not love maths, but you sort of enjoy it a little bit more because you know, that you’re going to enjoy the class?

Mia: Yep.

Interviewer: Do you ever feel anxious about maths?

Mia: Not really.

Interviewer: It doesn’t bother you?

Mia: Ah, during, obviously during tests but I think that’s everyone. Like I’m always scared I’m just going to go blank.

Interviewer: So your anxiety to do with maths is tied up with the testing?

Mia: Yeah.

Interviewer: Do you think we test too much?

Mia: Um, not really I think it’s good like to do a good amount of tests?
Interviewer: So you see the purpose of doing tests, you can see why we do them?

Mia: Yep.

Interviewer: Do you think being good at maths is important?

Mia: Very.

Interviewer: Why’s that?

Mia: Ah, cause like, it gets you through life I guess.

Interviewer: In what way?

Mia: Like if you have a higher maths score you get a better job, if you get a higher ATAR score it sets you up I guess.

Interviewer: So do you think you’re good at maths?

Mia: Nope.

Interviewer: No? What makes you think you’re not good at maths?

Mia: Um, I just don’t do as well as I could I guess.

Interviewer: You think you can do better, or you think you’re doing the best that you can and that’s just the standard that you get.

Mia: Um, I think I could do better if I push myself more.

Interviewer: So you see that there’s a value in doing maths? You see that value is to do with getting into a Uni course?

Mia: Yes.

Interviewer: And getting a good job? Is that right?

Mia: Yep.

Interviewer: Do you think there’s any difference with genders, with maths?

Mia: Um, well Mr Jones’s* convinced that, um, that boys are better than girls.
Interviewer: Really? Mr Jones* thinks that does he? What is his reason for that?

Mia: I don’t know but he just spent a lot of Year 7 and 8 that boys are better than girls cause they think more logically or something.

Interviewer: Do you see evidence of that?

Mia: I don’t know, I’ve never seen boys do maths?

Interviewer: Okay, do you see girls that are good at maths?

Mia: Yeah.

Interviewer: Many of them?

Mia: Yeah.

Interviewer: At this school?

Mia: Yeah.

Interviewer: Are you going to go on with, um, what maths subjects are you going do next year?

Mia: I want to do Further and Methods.

Interviewer: Both? And what’s the reasons for that?

Mia: Um, well my sister did them and she seemed to manage and yeah, just bump up the scores again.

* Not real name
APPENDIX G

Transcript of interview - MARGARET

Interviewer: Do you feel there is a culture of maths anxiety at this school?

Margaret: Yes there is

Interviewer: Yeah, What is the evidence?

Margaret: Um, there’s definitely a lot of tension prior to a test to the point where the girls want to know exactly what’s on the test

Interviewer: Yes

Margaret: Cause they don’t like taking risks, um, they like revision sheets that are almost identical

Interviewer: Yes

Margaret: And that’s not making a good mathematician

Interviewer: No

Margaret: Um and then it’s always ‘will I do this because it’s going to be on the test’ not for the sake of learning

Interviewer: Yeah

Margaret: But is this going to be on the test then I’ll focus on that if it’s not then I don’t want to know about it

Interviewer: Yeah

Margaret: But it doesn’t work that way you, need all your skills

Interviewer: Absolutely

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Margaret: Yeah
Interviewer: That’s so true
Margaret: Um and then I suppose there’s the numbers of further that are increasing so there’s good kids in further but then I think they’re used to be more methods classes now there’s more further classes
Interviewer: Yeah wow
Margaret: So what they’re saying to me is methods and Chem are hard so if I have to have Chem I can’t do two hard subjects so it would be better for me to do further
Interviewer: Oh right
Margaret: So because methods is not a prerequisite for a lot of things
Interviewer: Yes, but Chem is
Margaret: Yep, so they can tackle one hard subject
Interviewer: Yep
Margaret: And get an easier maths
Interviewer: That actually explains now why I have a few girls in my further class who do Chem, I thought that was an interesting combination but…
Margaret: Well if you’re going to do nursing or physio or something like that, you’re better off maybe be doing it that way
Interviewer: Yeah right ,That’s really interesting, um, so, you feel that there is anxiety around high stakes testing?
Margaret: Yeah definitely
Interviewer: Do you think we test too much?
Margaret: Um, no because I think the research shows that you need to test frequently but give feedback frequently, so from that perspective I don’t think we overdo it

Interviewer: Yeah

Margaret: Because they need constant feedback

Interviewer: Yeah

Margaret: Um, so no, I don’t think we do, um

Interviewer: So, where do you think that anxiety about the testing comes from?

Margaret: Oh I just think the expectations from their peers and from their parent is really high

Interviewer: Yeah

Margaret: So they get very anxious about the grade, so to speak

Interviewer: Sure yeah

Margaret: So if you’re in a normal high school you know an ATAR of 70 would be fine, but her an ATAR of 70 is considered a failure

Interviewer: Yeah wow

Margaret: So the expectations are high

Interviewer: Yeah

Margaret: Um and and they’re too hard on themselves in that sense

Interviewer: Yeah

Margaret: You know yeah

Interviewer: So true
Margaret: Yeah, but there is an anxiety because I know when we were doing the School Improvement Framework, a whole lot of students were interviewed, and it came up very clearly that, um, maths was a problem for them

Interviewer: Really?

Margaret: Yep, very anxious about maths

Interviewer: Yep

Margaret: Saying ‘I can’t do it’ and yeah

Interviewer: Yeah

Margaret: Which surprised me because, the, the feedback which got form that survey was more about the general processes within the school while this was very focused on maths

Interviewer: Maths? Isn’t that interesting?

Margaret: Mmm

Interviewer: You said that a lot of the girls say ‘I can’t do it’, ‘I can’t do it’, do you think there is a self confidence, self concept, um, influence there? Do you think…?

Margaret: I... yeah, it is a confidence thing I think a lot of them are capable but aren’t willing to put in the work ,they don’t have the work ethic to tackle it

Interviewer: Yeah

Margaret: Um it’s a bit like ‘if I don’t pick it up the first time, I’ll never be able to do it’.

Interviewer: Yeah

Margaret: And the work ethics not there, they don’t understand that, you know, everybody’s got to go home and work for a couple of hours before they pick something up
Interviewer: Absolutely and when they learn it it’s not necessarily there, you have got to do it again the next day just consolidate it

Margaret: Absolutely exactly

Interviewer: They don’t have that persistence that’s that’s required

Margaret: No no they don’t, that’s exactly right

Interviewer: Yeah, it’s really interesting, um, do you think there is a difference between boys and girls? You’ve taught both?

Margaret: I’ve taught both, I taught at Grand Hill* and Demonsland Grammar* and that was co-ed, um, boys definitely feel, my impression back then, was that boys would have a go no matter what

Interviewer: Yeah

Margaret: And boys who were even, were not good at maths insisted that they had to do methods there was no two ways about it where as a girls could be quite capable, but then pull back and be more cautious about what her, what maths she was going to do

Interviewer: Yeah, yeah

Margaret: So girls do definitely much more cautious

Interviewer: Yeah, and you notice that here even though there aren’t any boys here?

Margaret: Um, yeah, like I said, I think they’re choosing further because they are worried about too difficult subjects so they choose Chem…

Interviewer: Yeah
Margaret: And further so that they know they don’t have to spend as much time on methods sorry further as they would on methods

Interviewer: Yeah, I have one girl in my Year 12 that admitted to me, she chose further so she could focus on everything else cause she knew she could do further well without doing homework on it…

Margaret: Yeah, yeah, so they’re trying to save time yeah

Interviewer: Yeah, but she actually told me that

Margaret: Well, I suppose at the end of the day, they’re trying to get the highest possible ATAR aren’t they?

Interviewer: Yeah

Margaret: So they’re strategically choosing things that

Interviewer: Whatever works for them … So if they didn’t need it for a prerequ. and she thought that’s the best way to go then..

Margaret: Exactly

Interviewer: She does really well, she’s my, she’s my best student

Margaret: I honestly think we would, I know its controversial, but reckon we could cater for them better if they were streamed, even if it was loose streaming

Interviewer: Yeah

Margaret: With movement, cause, most of the class are blocked on anyway

Interviewer: Yeah

Margaret: So you could, really, focus it and then let them, sort of, have the responsibility moving up
Interviewer: Yeah
Margaret: You know, ‘if I get good grades, I can move up a bit’
Interviewer: Yeah, yeah
Margaret: Rather than, um, you know, just having them all jumbled up
Interviewer: Absolutely because I’ve got that girl but I’ve also got another girl, who is really weak
Margaret: Yeah
Interviewer: And it’s just really, I find it challenging to pitch the class right at the right place
Margaret: Exactly
Interviewer: And sometime you say right, If you’re happy, go ahead, try the exercises, now I’m going to do another one, you know, so you’ve just got to find these strategies to …
Margaret: Exactly
Interviewer: But your’e right if we had them, say, all the Methods girls, or girls that …
Margaret: Well its coming up, we will have them all split up in Year 10
Interviewer: Yeah
Margaret: But at the moment I’d have five that could do with a small group situation
Interviewer: Yep
Margaret: All the time
Interviewer: Yeah
Margaret: Yeah
Interviewer: Yeah, I’d probably have a couple as well. That’s really interesting, um,

Margaret: But the other thing is, they do have a good attitude towards small group

Interviewer: Yep

Margaret: They don’t see that as being a failure or whatever, I think the small group’s worked well here

Interviewer: Yeah, that’s really good, there is no, sort of, judgment about it or…

Margaret: Nope, not at all,

Interviewer: And its supportive for those girls who do it. Oh, isn’t that good?

Margaret: Yeah

Interviewer: That’s really interesting cause that’s often, comes up that, ah, you’re judged if you’re not good at maths

Margaret: Yeah

Interviewer: So, oh that’s good, so, what are some of the reasons you think that students choose inappropriate subjects? So if you have a really strong kid, and you’ve mentioned about the workload, are there any other things, or have a really weak kid that chooses maybe methods when they are not capable?

Margaret: Well, the workload issue is a big one here, cause they are so committed to lots of co-curricular, but if you do have a weaker kid whose insisting on doing Chem, well, not Chem, but Maths…

Interviewer: Yeah
Margaret: It’s generally because they have suddenly decided they want to do something and it is a prerequisite

Interviewer: Yep

Margaret: So really, they’ve only checked that out say midway through Year 11 or at the end of Year 11

Interviewer: Mmmm

Margaret: So in which case they haven’t got the skills to justify doing that subject

Interviewer: Yeah

Margaret: Or, there is pressure from home

Interviewer: Yep

Margaret: um, they are the two main ones

Interviewer: Yeah

Margaret: Um, so you know, there inappropriate choices only because they are not capable or, well, they are not capable and they really they are not identifying what they’re suited to

Interviewer: Yes, yeah

Margaret: So in that situation they need serious counselling

Interviewer: Yeah, absolutely, um, apart from parents are there other social pressures do you think there’s, from other girls or ..

Margaret: Um, no, no, I think from what I’ve seen Year 11, they, I don’t think they’re following their friends

Interviewer: Mmm
Margaret: I think it’s either prerequisite or pressure from home

Interviewer: Yep

Margaret: Um, no, I don’t see it from that perspective

Interviewer: Yeah good

Margaret: Maybe in Year 10, they’re thinking ‘well, everyone’s going to methods, I should do it too’

Interviewer: Yeah

Margaret: But at Year 11 the end of Year 11 they’re pretty yeah

Interviewer: It’s about them

Margaret: Yep, yep

Interviewer: Yeah, um, I think that everything.

* Not real names of schools
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