MATHEMATICS AS A SECONDARY SUBJECT: THE GIRLS’ VIEW

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Mathematics evokes a range of negative emotions from many girls as they struggle to see its worth. Many girls hate mathematics, they view it as unimportant and boring, and they enjoy their other school subjects far more. In contrast, other subjects are often described using positive adjectives such as fun, enjoyable and creative. Hegemonic traditions and masculinised methods of teaching and learning continue to influence the curriculum and teaching of mathematics, and result in disengagement of girls from this important school subject.

This master’s thesis research is a study of a group of fourteen Year Twelve New Zealand girls. Discourses of disadvantage in New Zealand educational circles have focused on boys’ underachievement in the school system and the small numbers of students entering STEM pathways post-school. This focus has drawn the attention away from the many cases where girls of all abilities chose lower-level mathematics courses, opted out of mathematics altogether, or just failed to engage with, and enjoy mathematics. The research, reported in this thesis, addresses the gaps in the literature by contrasting the girls’ experiences in mathematics to their experiences in other more traditional ‘feminine’ school subjects such as drama, food technology and English, to highlight differences and unpack girls’ preferences for their learning experiences.

Four different year twelve mathematics classes were observed at least four times each in this research. The girls’ were also observed forty-two times in their other school subjects. Twenty-two interviews were conducted and then transcribed. Discourse analysis of the qualitative data, drawn from the interviews and classroom observations, was informed by poststructural theory. Specifically, this research unpacked the multiple and often, competing discourses within which these girls were positioned through their experiences of school mathematics. Poststructuralist tools allowed for (re)telling, unpacking, and troubling the stories of how this group of female students experienced mathematical space in the context of their everyday experience of secondary school.

The research identified that traditional pedagogies that involved teacher-directed classroom spaces dominated their experiences of mathematics. There was very little opportunity for discussion and group work in mathematics. The girls were able to move freely around the rooms in other subjects; they were able to control their own learning progression by having freedom to construct their own knowledge production in collaboration with others by discussing their work with both the teacher and their peers. Rarely in mathematics did the girls experience practical, hands-on activities, and rarely did they see any practical uses for
the mathematical skills they were being taught. Realistic contexts were missing and they found it difficult to link mathematical ideas to real-world experiences. Tensions arose because mathematics was often sold to these girls as something useful for their futures, however their experiences left them confused about this usefulness. These negative experiences of mathematics influenced whether these girls chose to continue with mathematics in the future.

This research showed that the girls preferred their other subjects and subject teachers to mathematics and their mathematics teachers, often describing their other subjects as more engaging, more useful and more thought provoking. Only three of my research participants wanted to continue with mathematics in the year following from this study. For the other eleven disengaged girls, their other school subjects provided them with more appealing pathways for learning and because of this their mathematical journey ended. The learning of mathematics is far too important to be discarded in this way.
ACKNOWLEDGEMENTS

A few years ago I was given a piece of yellow paper with the quote “Don’t get it right, get it written” on it. This piece of yellow paper has followed me through each house move and is always stuck to the wall next to my computer between another piece of paper with my thesis topic written on it and a Zits cartoon (see below). Sometimes, as the years have passed, that yellow piece of paper has been all that has kept me going, that and the following people who kept me on track to finally finish this PhD.

My Thesis:

“Mathematics as a secondary subject: A girls view”

“Don’t get it right, get it written.”

(p. 17)

Writing for publication, Sage, London.
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Finally, thank you to all of the girls I have taught in the past, that I teach now, and hope to teach in the future. Your mathematical experiences matter to me and I promise to always aim to ensure every girl leaves my classroom saying they enjoyed learning mathematics.
We are sad that you are leaving! We will really miss you next term for you are a wonderful maths teacher. You have a wonderful mind that knows how to make maths fun for children but also makes them to learn new things. We are thrilled with your teaching and ask you to stay. Throughout the year we have learnt so many new things that will have impacts on our future careers. We hope waiting till next year won't be a long time for we can't wait! This is all from Year 7.
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CHAPTER ONE: INTRODUCTION

This thesis is about a group of fourteen female students who studied mathematics at secondary school. These girls also studied a range of other school subjects, which included many arts subjects such as English, music, and history. This thesis articulates the girls’ views and experiences of school mathematics as compared to their other school subjects with the goal of giving them a ‘voice’ in an educational system that purports to recognise, appreciate, and address the individual needs of all students. It is necessary for females’ voices to be clearly heard in feminist perspectives of research (Gray, 1996; Jones & Jacka, 1995). These girls have agreed to allow me to listen and report on their voices so that they can actually be heard, however, it is possible that “in “recognising” girls’ disadvantage in education we have also helped re/produce it” (Jones & Jacka, 1995, p. 165). In writing about girls, I have to take care not to construct ‘girls’ in such a negative way that all I do is continue to reinforce girls’ mathematics experiences in a language of disadvantage and thus constitute them in “particular and limiting ways” (Jones & Jacka, 1995, p. 167).

Some girls view mathematics as intrinsic to their schooling, but fail to engage in and with the subject. They study mathematics because they feel they have to. For many their enjoyment of mathematics is limited, they enjoy their other school subjects far more and for a variety of reasons (Francis, 2010b). These girls often did not recognise the mathematics component inherent in their other subjects and saw their mathematics class/classroom as a place filled with rules and regulations, some of which did not appear in their other subject spaces.

In studying these girls’ experiences of mathematics it became apparent that mathematics did not offer them the kind of learning experience that they felt comfortable in. The ‘mathematical space’ made available to these girls is not allowing them to engage in mathematics as is intended by the school, the curriculum and their teachers. These girls often felt more comfortable in the spaces provided by their other school subjects. These issues, intertwined with my own experiences of mathematics and mathematics’ teaching, form the foundation for this thesis. This chapter begins by outlining some of the context of school mathematics in New Zealand with a particular focus on how the curriculum positions girls in mathematics. It then discusses the rational for the thesis; the research questions and concludes with an outline of the organisation of the thesis.
Schooling and Curriculum in New Zealand

The Ministry of Education website (Ministry of Education, 2015) states it is compulsory for children in New Zealand to attend school between the ages of six and sixteen, although most children start at age five. Children begin school in either Year Zero or Year One and the final year of schooling is Year Thirteen. Schooling is for four terms each year from February to December with students having around twelve weeks holiday per year. The holidays are slightly longer for students in the examination years; Year Eleven through Thirteen. The New Zealand government funds most schools, and schools are expected to operate under the guidelines of the New Zealand Curriculum Framework (Ministry of Education, 2007). Mathematics is one of the essential areas of learning in the framework.

The Ministry of Education launched a new mathematics curriculum in late 2007. Mathematics was renamed mathematics and statistics and the specific document was abbreviated significantly. However, the mathematics curriculum being used during the research period (2004-2006) was Mathematics in the New Zealand Curriculum (Ministry of Education, 1992). For the most part, this is the curriculum referred to in this thesis. Since 2007, there have not been a lot of curriculum changes as far as the content to be taught, however, the assessments have been realigned to more closely match the curriculum over recent times. Number, measurement, geometry, algebra, and statistics were the knowledge and content areas (called strands) with the mathematical processes strand (problem solving, reasoning, and communicating mathematical ideas) supposed to be taught alongside and as a part of the other content strands (Ministry of Education, 2007). The teaching of mathematics in New Zealand closely aligns to international approaches to teaching mathematics. New Zealand’s particular cultural and social norms, school governance systems and community contributions also influence how schools teach mathematics (Ingram, 2011).

The National Certificate of Educational Achievement (NCEA) is the main qualification for New Zealand secondary school students and its introduction from 2002 influenced and in many ways, changed how mathematics came to be taught (Hagan, 2005). Until 2002, students’ performance in a wider range of competencies and skills was often not taken into account as only some subjects had formal external examinations. Examination marks were scaled so that only a certain number of students could pass each year and internal assessments results scaled to match external assessment results, even when assessing completely different skills.

The NCEA system aimed to provide a more accurate and equitable picture of a student’s achievement because a student who had gained credits for a particular standard had
demonstrated the required skills and knowledge for that standard. Each student receives a School Results Summary that presents all standards taken throughout their school years, and the results for each. Whether this summary is useful to prospective employers and tertiary educational institutions and whether NCEA has improved educational success and standards of enrolments at tertiary level have changed needs further research (Shulruf, Hattie, & Tumen, 2008, 2010). NCEA standards can be internally or externally assessed. Each standard is worth credits (normally between two and five) and can be awarded as achieved, merit or excellence.

Level one aligns with Year Eleven, level two with Year Twelve and level three with Year Thirteen. There can be some flexibility in individual programmes of study to meet the needs of individual students. The girls who participated in this research were in Year Twelve and doing courses of study at NCEA level two. To gain entry to level two students must have at least eighty credits from level one standards. In Year Thirteen mathematics splits into two courses; mathematics with statistics and mathematics with calculus.

Who studies mathematics and why

Mathematics is studied at school because it is a compulsory subject until Year Eleven (and in some schools Year Twelve). It is called a core subject and the Mathematics Curriculum (Ministry of Education, 1992) includes detail about the importance of learning mathematics. The following ideas were taken from the document:

- Mathematical understanding and skills contribute to aspects of a person’s self-worth, control of their lives and ability to play a responsible role in democratic society
- Mathematics education encourages a belief in the value of mathematics, its usefulness; it nurtures confidence, fosters a sense of personal achievement and, creates continual and creative interest in mathematics.
- Mathematics provides the mathematical and statistical literacy needed in an increasingly technology and information-rich society (see (Ministry of Education, 1992’, p. 8)).

These ideas are surrounded in many discourses related to both the individual and to societal needs of mathematically literate individuals (Lundin, 2012). Discourses are described as structures of language and practice through which objects come into being (Foucault, 1972). These discourses such as understanding, self-worth, control, usefulness, and confidence position mathematics and the mathematics learner in a particular way by trying to
link the needs of the individual to the needs of society in general. Much of this discourse is still implied in the new curriculum document.

The new curriculum introduced in 2007 says that mathematics and statistics “equip students with effective means for investigating, interpreting, explaining, and making sense of the world in which they live” (Ministry of Education, 2007). It also suggests students will develop many attributes such as thinking creatively, critically, strategically, and logically and that “mathematics and statistics have a broad range of practical applications in everyday life, in other learning areas, and in workplaces” (Ministry of Education, 2007). The implication is, that through the teaching of school mathematics, a student will develop the necessary skills to be able to engage as a numerate, competent, mathematically-able citizen in the future.

Mathematics is perceived as being critically important as a bridge to a stable and successful future in a student’s education and career opportunities (Brantlinger, 2014; Gutstein, 2012). This opinion continues to be held by the general public, parents, politicians and the professional world of business and academic institutions (Anthony & Walshaw, 2007; Ma, 2001b). Tertiary institutions have long held the power to determine which school subjects are, and are not, important (Kenway, Willis, Blackmore, & Rennie, 1998).

In today’s climate of competition for tertiary places, choices of subjects are likely to be strongly influenced by tertiary prerequisites [and] given the frequency with which mathematics acts as a prerequisite for tertiary places, it is likely that this will be an important factor in choosing mathematics. (Johnston, 1994, p. 235)

Mathematics is often placed as a high-priority prerequisite for many courses and careers. For example, to enter an engineering course at a university in New Zealand, a student requires eighteen level three calculus credits. For students considering such tertiary options it is vital that they choose mathematics at school and achieve good results or they will be excluded from admission. The prerequisites, which are set for particular courses, determine a “knowledge hierarchy” (Kenway et al., 1998, p. 73) for school subjects. The promotion of mathematics as a prerequisite for many courses disregards the fact that a substantial amount of the mathematics learnt at school has no relevance to the particular courses that require it. Unfortunately, many pathways which specify mathematics as a prerequisite do not draw directly on the mathematical concepts learnt at school, but are still used as the selection device (Boaler, 1997b; Brantlinger, 2014; Johnston, 1994). In spite of this, mathematics continues to be valued as more important than many other school subjects. Mathematics is often considered a subject for boys, that is, masculine, and as such it is often valued more than other subjects which are more associated with the feminine such as food or fabric technology or drama (Abbis, 2005; Davies, 1997a; Harris, 1997; Shashaani, 1995). Mathematics is placed
high on the subject hierarchy of which subjects are deemed the most important and as such hold the most power (Kenway et al., 1998).

It is the carefully fostered belief that all people who can do competitive forms of mathematics are more intelligent than all those who cannot, together with the practices associated with this view, which should be the focus of those who wish to assist girls and others who are excluded from many occupations in the name of mathematics. In my view, mathematics is too good to be used for such dishonest ends. (Willis, 1989, p. 36)

There needs to be considered thought given to how mathematics is used as a device to rank people according to intelligence, and maybe even worth, and how this reinforces notions of mathematics as a male zone of achievement and learning. Mathematics skills have far wider uses than only for selection purposes and this needs to be valued more than any role it has in sorting for future careers.

Mathematics is used as a selection tool (Ernest, 2007; Gates & Jorgensen, 2009; Martin, 2003; Watt, 2010). Its role for many in the tertiary sector is to specifically indicate a student’s general academic ability. A broad education is promoted for students at school, but as long as mathematics is used to control entry to further pathways this subject will remain dominant in considerations about subject choice and many girls, through opting out, will continue to be pigeonholed into a mediocre selection of career opportunities (Gates & Jorgensen, 2009).

Schools, classrooms, and many families have mirrored the male dominated distribution of power in society. Mathematics education itself has mirrored the societal distribution of power (Burton & Townsend, 1986) and continues to do so for many. If males still dominate the management of most schools then this will be reflected in the way schools operate and the decisions that are initiated and made. Male work methods, male tendencies and subjects identified as males achieve higher status and a greater predisposition to operate within schools and in the wider society, and with their higher status comes greater earning capacity (Burton & Townsend, 1986; Schneeweis & Zweimuller, 2012). Unfortunately this masculinised hierarchy of school operation, which privileges men, filters through to how subjects are staffed, taught, funded, and often appreciated on a day-to-day basis with little understanding of the widely ranging needs of students as a whole.

To be good at mathematics is perceived by many as an indication that you are good at everything. How did mathematics become so powerful?

We are told that mathematics is powerful and that learning mathematics will give us power... Learning a lot of mathematics can give you power - but for many people it is not personal power - their experience of learning mathematics is that it makes them feel quite powerless. For them the power resides not in the mathematics but in the myth of mathematics
- in the meritocratic prestige of mathematics as an intellectual discipline (Willis, 1990, p. 205).

For many students, their experiences of school mathematics are personally disempowering (Mendick, 2003). They may achieve satisfactory grades but the overall experience perhaps leaves them wondering what mathematics has really taught them. The may feel deceived by the ideas presented that knowing mathematics will make them more powerful in society. The ‘myth of mathematics’ needs quite a bit of unpacking and there are many different opinions as to what mathematics is really all about in society, schools, and academia. It appears that mathematics has developed an aura of its own. Mathematics has been shown to alienate many people and Willis (1990) suggests that this happens for more girls than boys. The prevailing discourses are “maths as hard, maths as currency in the labour market, and maths as boring and irrelevant” (Mendick, 2003, p. 171). Mendick suggests that these discourses have become powerful in mathematics because “they determine what can be said about something as well as who can say it, and even what can be thought or imagined” (p. 171). The mathematical discourses influence an individual’s educational choices, experiences, and emotions in mathematics. Dunne and Johnston (1994) share the view that:

The power and position that mathematics holds as a discipline inevitably remains inviolate in the gender and school mathematics research, where the implicit message seems to be that all will be well once sufficient (but clearly not all) girls have access to the power and privileges of maths. (p. 222)

This suggests that if girls access mathematics they will have subsequent access to the power it affords others. This view still focuses on girls having to somehow gain entry to the world of mathematics instead of the world of mathematics, and the people within that world, changing to allow them entry on their own terms. Davies’ (1993) discussion of subjectification is important in the context of mathematics holding so much power. She recognises how individuals are shaped by others; in the case of mathematics this can be interpreted as male thought shaping what is mathematics. Poststructuralists focus on the way “each person actively takes up the discourses through which they and others speak/write the world into existence as if it were their own” (Davies, 1993’, p. 13, original emphasis). For many centuries now, mathematics has been seen as a male domain and even today how mathematics is positioned in schools and society is accepted as how it should be by those who un-questioningly take up discourses that position mathematics as determining their futures (Brantlinger, 2014).

During the time period of the data collection for this research, media discourses in New Zealand told us that it was boys who had problems in schools and that girls were outstripping
them in all aspects of education (Fox, 2003; Schaer, 2004). In mathematics, the evidence did not support this view. Girls were then, and still are; continuing to leave the study of mathematics to boys, and in doing so, limit their access to many future opportunities post-school. Prior to the introduction of NCEA, the examination data collected from 1998-2003 provides evidence that the numbers of girls entering the external examination in mathematics were significantly lower than boys. This is particularly the case in the mathematics with calculus option, but mathematics with statistics also shows discrepancies in numbers of girls and boys with numbers favouring boys (New Zealand Qualifications Authority, 2004).

Analysis of data from the New Zealand Qualifications Authority (NZQA) shows that over the years 2004 to 2013 there have been more boys than girls studying mathematics standards in Year Thirteen. This is the final year of schooling and in many schools the first time that mathematics in not a compulsory school subject. The data available is given as the number of entries in each standard and the percentages of achieved awards. The data was split into unit standards (all internally assessed), internally assessed achievement standards and externally assessed achievement standards. The data is reported by gender and also ethnicity. The entry and achievement data grouped by ethnicity is interesting in itself, but for this thesis is outside the scope of the research.

The differences in the number of entries for girls and boys in the mathematics with statistics course is on average about 2000 in favour of boys. In mathematics with calculus this difference jumps to on average 10000 (New Zealand Qualifications Authority, 2014). Calculus is deemed to be the harder of the two courses and also it is the course most used as a prerequisite for entry to some specific university courses such as architecture and engineering. In the higher-level scholarship courses at level three there were more than double the number of entries in the examinations from boys than girls (New Zealand Qualifications Authority, 2014).

The recorded data also points to the fact that before students reach first-year university much of the filtering of all students from studying mathematics has occurred. There is a significant drop off between the number of total standards entered in Year Twelve compared to Year Thirteen (New Zealand Qualifications Authority, 2014). As worrying as this trend is, this thesis is more concerned with the lack of retention of girls particularly in mathematics in Year Thirteen and beyond school. More recent research and media discourses focus on STEM (science, technology, engineering and mathematics) related investigations with the suggestion that the way forward for young people is to consider and take up training and careers in STEM related areas. Mathematics is seen as providing the tools needed for jobs associated with: physics, computers, stock markets, genetics, neuroscience, and ecology (Renert &
Davis, 2010). Technological developments in the future will require strengths in arithmetic, algebra, and calculus. The concern is that if girls do not study mathematics in their final years of schooling that they will not be positioned to take up opportunities in STEM occupations and that this may keep them in lower paid jobs in the future (Forgasz, Leder, & Tan, 2014; Office of the Chief Scientist, 2013; Velayutham, Aldridge, & Fraser, 2012; Watt, 2010).

Choosing not to pursue mathematics has been attributed to the difficulty of the subject, the culture of mathematics and the lack of relevance of mathematics to their future (Shannon, 2004). Students may drop out of mathematics because they lack the desire to continue (Ma, 2001a). Often this decline in participation is not because they do not have the cognitive ability to continue to study mathematics. Their decisions are influenced by many factors such as: their experiences of school mathematics, their emotional engagement with mathematics, the perceived usefulness of mathematics to them personally, and their preferences for studying their other school subjects. This thesis focuses on how girls experience school mathematics and how these experiences intertwined with other influencing factors affect their enjoyment, engagement and later their choice to continue on with studying mathematics.

**How the curriculum ‘defines’ a girl**

The concept of catering for the individual needs of “all students regardless of ability, background, gender, or ethnicity” (Ministry of Education, 1992, p. 12) is an important aspect of the mathematics curriculum. What I aim to show, through an analysis of the use of the words girls, female, and women and the text surrounding these words, is that the curriculum document suggests a particular version of a girl in mathematics and at the same time positions her as being a certain way in mathematics.

In the next section I examine the discourses present in the curriculum document (Ministry of Education, 1992). I believe that by acknowledging the mathematical ‘disadvantage’ of girls in the text of the curriculum document, the authors have “re/produced” it (Jones & Jacka, 1995, p. 165). By identifying girls as deficient in terms of their mathematics, the document constructs girls’ mathematical experiences in specific and restrictive ways. In this section, I will analyse some sentences from the document and comment on how I believe girls are positioned by the construction of the words in each sentence. At this point, I must indicate that these are my own interpretations and may not reflect the opinions of others. Nonetheless, I argue these constructions powerfully shape the context of the mathematics institution the girls in the research received.
The document recognises that many of the contexts that have been used in the teaching of mathematics have not reflected the background of girls in mathematics classes. Many contexts are seen as “irrelevant and inappropriate” (Ministry of Education, 1992, p. 12) and this contributes to a lack of engagement with mathematics. Learning mathematics in isolation from experience and culture does not allow girls’ interests to be used as a starting point for developing knowledge and skills. Girls’ “interests have been subordinated, separated or devalued” (Walshaw, 1999, p. 135). The girl is constructed as not being able to do mathematics unless the teacher is able to determine the life experiences of individual girls and rebuild the classroom environment to reflect their needs.

This does not give girls a ‘voice’ but rather situates the teacher in the powerful position of deciding what is appropriate pedagogy for girls in mathematics. I believe that it is unlikely that any teacher is going to be able to cater for all individual’s experiences in their lesson planning and that the discourse here suggests that girls cannot learn mathematics unless the teacher can change their teaching. The text of the curriculum document uses mathematics and the teaching of mathematics as a method of promoting and then dealing with ‘the girl problem’ by suggesting that teachers will have to interpret the document and reproduce it in the classroom environment as being appropriate and applicable to girls and their experiences.

This reinterpretation and reanalysis of the curriculum positions classroom teachers as fully responsible for student learning. In New Zealand, attendance and conversations at association meetings and courses/conferences indicates that the mathematics teaching force is ageing, and predominantly male and suffers from huge attrition rates to such an extent that many ‘hard-to-staff’ areas of the country are having to use non-specialist mathematics teachers to fill in the gaps. At the NZAMT (New Zealand Association of Mathematics Teachers) meeting in 2001, which I attended, we were informed that the Northland Mathematics Association was defunct as there was only one full-time, qualified mathematics teacher in that region. My point here is that to expect mathematics teachers in general to have the skills to contextualise the curriculum document to suit the needs of all of their students disregards the fact that most teachers are probably struggling to come to terms with the subject matter in the first place. Having to think outside the subject content and teach in a way that caters for individual needs may be asking too much of this group of teachers. Unfortunately, these non-specialist mathematics teachers may end up teaching mathematics to their students using exactly the same methods and strategies with which they were taught during their mathematics schooling. This may further isolate groups such as girls from engaging in mathematical encounters that reflect their interests and experiences.
There will never be one relevant context for all girls as the group ‘girls’ is far too diverse to contemplate a ‘quick-fix’ approach to mathematics teaching. There is also an assumption here that a change of context is what girls actually want and this may not be the case. Girls’ experiences in the mathematics classroom may have more to do with the influences of the teacher and other students than how the curriculum is presented. It is difficult to place girls in one cohesive group as they all have individual interests and needs that need to be treated in different ways and use different pedagogies. If we classify girls into one group their individual needs may be ignored and instead of changing the curriculum the focus may be drawn to treating the girls differently, and in a particular way, hoping to solve all the issue in one go (Jones & Jacka, 1995).

The curriculum document raises concerns about awareness of issues for girls in mathematics (see (Walshaw, 1999)). I cannot see that an ‘awareness’ of the need for relevant contexts for girls improves access for girls to mathematics. Schools making mathematics compulsory at Year Eleven have improved access to mathematics over the last decade, not an awareness of issues. I am making a distinction here between accessing mathematics as a course and accessing mathematics as an altered subject with a curriculum built around the needs of the learners. By continuing to talk about participation rates, I suggest that the word access is being used to recognise how many girls do mathematics, not how much more accessible the curriculum has become.

Compulsory mathematics up until Year Eleven was a directive from the Ministry of Education based on statistical evidence that girls were not participating in mathematics at higher-levels (Walshaw, 1999). Unfortunately, this lack of participation still continues and mandatory mathematics at Year Eleven and/or Twelve will not in itself solve the problem of lower participation rates in Year Thirteen. If girls do not enjoy mathematics or see any relevance in what they do in the classroom they will opt out at the first opportunity.

The limiting of later opportunities for girls and women discourse appears in the curriculum document and reinforces the notion of mathematics acting as a ‘critical filter’ or ‘gatekeeper’ to many tertiary courses and to future employment (Brantlinger, 2014; Ernest, 2007; Gates & Jorgensen, 2009; Martin, 2003; Sells, 1978) (Watt, 2010). This section of the curriculum document reinforces the discourse of mathematics as being useful for later life, but ignores any mention of girls wanting to continue to learn mathematics because it is an intrinsically valuable subject in its own right (Boaler, 1997a). Positioning yourself as a ‘maths person’ requires compliance by acting out the role of the obedient, docile learner – a loyal, member of the boys’ club who does mathematics not because of its intrinsic value as a
subject, but because it increases their economic viability and entry into the working world of men (Lee & Taylor, 1996), reinforcing the hegemonies of mathematics (Brantlinger, 2014).

The curriculum document suggests that teachers need to recognise the strengths and interests that girls bring to mathematics (Walshaw, 1999). This interpretation of girls’ strengths in mathematics comes from the curriculum text where mention is made of co-operative learning tasks and extended investigations. This is problematic as there is an assumption here that all girls like to work collaboratively and that all girls like investigative mathematical problems. This continual treatment of girls as one massed group is disturbing, as this assumes that girls are a homogeneous group who all learn and work in the same way. Walshaw (1999) suggests that indicating that girls like collaborative and investigative work positions them as learners entering from a different location and with a different motivation from boys.

Girls are also constructed as passive subjects in the mathematics classroom by the document suggesting that teachers should use techniques that help to involve girls actively in the subject. This implies that a girl needs to be active to learn mathematics. I suggest that the word passive is a female gendered term and active is a male gendered term and that, by indicating that girls need to be more active in mathematics, the curriculum document claims that girls need to be and learn like boys in mathematics. Lee and Taylor (1996) reinforce this when they identify the notion of passivity as a submissive/feminised relationship to knowledge.

The curriculum text determines what counts as mathematics and how school mathematics is gendered. Girls, we are told, may lack confidence; are good at routine mathematical operations; and at problems that require a single method and have a single solution. In contrast, boys are confident; they can do skills essential in mathematics; they can solve problems using any number of methods; and come up with many different solutions (Walshaw, 1999). Girls are deemed to lack “autonomy over their own schooling and they are in need of liberation from oppression” (Walshaw, 1999, p. 133). The words in the curriculum document (Ministry of Education, 1992) “needs to be accompanied” (p. 12), “will help them” (p. 12), “need to be encouraged” (p. 12), and “will help girls” (p. 12), position girls as needing assistance to escape from their own gendered way of learning by others, who know better ways and can thus fix the deficiencies of girls. Many authors discuss this ‘problem’ of girls not being able to do mathematics the ‘right’ way and the following discussion looks at how girls’ methods of learning, as constructed in the text of the curriculum document, need to be addressed for them to succeed (Burton & Townsend, 1986; Leder, 1990a; Leder, 1990b; Schneeweis & Zweimuller, 2012; Walshaw, 1999; Willis, 1989, 1990).
Applying of mathematics to unfamiliar situations is deemed one of the critical components of mathematics education. Clark et al. (1994, cited in Alton-Lee & Praat, 2000, p. 109) have concerns about the increased emphasis in the curriculum document (Ministry of Education, 1992) on such problem-solving processes, believing that this may further disadvantage girls due to international evidence that girls do not achieve well on tasks which require them to use applied mathematics and problem solving strategies. It has been shown that boys tend to do better on tasks requiring the transfer of their learning to new situations, whereas girls like to “learn what is taught” (Fennema & Meyer, 1989’, p. 149). Of course, we have to be cautious about such claims, given my earlier argument that girls do not form a homogenous group.

The 1972 curriculum (Department of Education) suggested building children’s confidence by allowing them “to make mistakes” (Department of Education, 1972’, p. 6). This is an unfortunate choice of words as, even though the intention was to introduce more problem-solving and investigative work, research showed that girls do not like having a go or making mistakes in mathematics (Fennema & Meyer, 1989). They like to know how to do the problem and often need encouragement to attempt things for themselves. The mathematics curriculum (Ministry of Education, 1992’, p. 9) still uses the word mistakes, which implies that until you get it right it is wrong. In science, they use the word ‘experimenting’, which adds emphasis to the “efforts, processes and playing around with a problem” (Haynes, 1994, p. 5). Perhaps encouraging girls to focus on the processes in mathematics rather than the correct answer may eliminate the fear of being wrong.

When there is a continued focus on right or wrong answers rather than methods, girls may turn their focus to correct computational skills rather than problem solving processes which require a higher level of thinking. It follows then, that the process of framing what girls do best as lower level computational skills reinforces the view that “female behaviour is less competent than male behaviour” (Damarin, 1995’, p. 246) because if more boys attempt the harder contextual problems then their overall results will be higher than their female counterparts. By identifying the correct and implicitly male behaviours it suggests that females must be taught these. When problem-solving processes are valued over computational skills, then the nature and meaning of female behaviour is ignored and unrecognised. This allows for the dominant group’s attributes to be seen as the powerful norm.

Enabling females to improve their performance and confidence in mathematics, particularly in the case of problem solving, requires better linkage between rote learning and new situations (Alton-Lee & Praat, 2000). It seems that girls shy away from areas of mathematics that require using known mathematics skills in less structured applications.
However, “learning styles may have more to do with behaviours traditionally thought appropriate to males and females than a stable cognitive structure” (Alton-Lee & Praat, 2000’, p. 126). In my experience, most girls are just as capable as boys of working on higher-thinking level problems, but there may have been an assumption in the past that only boys can do this work and thus many teachers may have not had an expectation of the girls they teach engaging in this problem solving process.

Often the “individual differences in learning preferences and styles are ignored as teachers initiate ‘analytical models of instruction’ which tend to favour males more than females” (Fox & Soller, 2001’, p. 16). Some research shows girls prefer to work collaboratively more than competitively (Head, 1996), but cooperative-learning activities will only benefit girls if the teacher considers the gender balance in class. Consideration of the make-up of groups, how instructions are given to students, and who takes on leadership roles in groupwork situations are needed to ensure equal participation. In my experience, the collaborative aspect of learning is completely ignored in many upper-secondary mathematics classrooms. This further reinforces the masculinity of mathematics as girls advance through the levels. Teachers may make Year Nine and Ten (students aged 13 or 14) mathematics accessible, but disregard the impact of removing collaborative learning from the senior curriculum.

A pedagogy that allows errors to be made, as part of the process of learning, will encourage students to discuss incomplete solutions and alternative interpretations with others (Boaler, 1997d; Head, 1996). This recognises the significance of the processes used in mathematics rather than merely the content. If girls are allowed opportunities to reflect on, and clarify their ideas, then mathematics will become a more positive experience. A fundamental understanding of mathematical concepts can only be attained from being allowed the time and space to grapple with the problems (Willis, 1989).

There are concerns about the use of more discussion in the mathematics classroom, a consequence of more cooperative problem-solving activities, as females may be placed in the uncomfortable position of having to voice their disagreement with peers (Ambrose, Levi, & Fennema, 1997). Girls may fear exposing the weaknesses of friends and thus jeopardising friendships. This may have been a particular function of the mathematics classroom that was researched where the atmosphere may not have been conducive to girls expressing themselves. Girls may not actively contribute to discussions because they undervalue their own understandings of the tasks, feel insecure about explaining their ideas, and lack the confidence to speak out in a group, or in a whole class environment (Ambrose et al., 1997). This may be more apparent in mathematics classrooms than in other school subjects. If
Learning requires active participation in discussions then groups of under-achieving students or shy achieving students may be disadvantaged in this situation but if they receive encouragement and gain in confidence at actively contributing then they may actually flourish.

A virtue of mathematics is that it can be seen as a truly useful subject, but there may not be a lot of faith that mathematical teaching and pedagogy at school is transferable for participation in real life situations and in a technological society (Gutstein, 2012) (Lundin, 2012). School mathematics may have three important uses: “socialisation, intimidation, and selection” (Willis, 1990’, p. 199). These uses may explain why some girls do not engage with the study of mathematics. Following directions, completing exercises by rote and automatically, working independently, being neat and punctual with work are termed mechanical performance skills and provide a very narrow form of socialisation. They are also the least required skills for future use, but are easier to teach. They are useful for teaching conformity and are good for authority and control in the classroom (Boaler, 1997a) (Mendick, 2006). Most girls tend to be good at these skills and this causes difficulties when they try to access higher level, more sophisticated mathematics. Girls may have learnt their lessons too well because they are unable to take their passively received knowledge and apply it to new concepts and situations. The skill to apply knowledge in new situations is seen as an essential part of the mathematics curriculum and one that girls must gain confidence in for future success in mathematics.

My mathematical story

Many teachers may believe that there is no girl problem in mathematics because they have seen improvements in girls’ achievement in this field. However, girls do still continue to dislike mathematics and they walk away from studying mathematics at the first opportunity they can. The reality of mathematics education is that it continues to operate with many of the same hegemonic traditions that it always had. Masculinised methods of teaching and learning instigated in our educational system and sanctioned from above by school administrators, both internally and externally, work against many girls. These methods cause them to experience a lack of engagement with the work of school mathematics.

Can I speak for all girls in mathematics? Many may say no, so I feel it is important to locate myself in my writing. As Jones (1992) recognises, “no research accounts [are] neutral” (p. 20) but as researchers there is often an expectation that we will write as though we have no attachment or relationship to the researched. I cannot hide in my text as I feel my own
experiences give me a “new visible entity” (Jones, 1992, p. 21). I feel it is important to describe my various positionings in relation to the girls that I wish to speak for.

At school I chose to do mathematics because I was good at it and I enjoyed the challenge of mathematics. I continued to study mathematics at university and to later train as a secondary school mathematics teacher. I have taught in coeducational and single-sex female secondary schools and have worked for many years in part-time positions as I have, and continue to, raise a family of two sons and two daughters. In 2001 I was appointed as head of mathematics in charge of a large (more than six teacher) subject department, in a school with only one other woman teacher in a similar managerial position. In 2003 I was awarded a teacher’s study award and in 2004 a university scholarship which has enabled me to continue my studies in education and provided me with the time to read, listen, converse, debate, and reflect on my experiences of schooling, and in particular mathematics education, as a teacher, student, and parent.

As a middle-class, tertiary-educated, mathematically-able woman who enjoyed and had positive learning experiences in mathematics, I am now automatically positioned differently to the girls whose views I wish to recognise and acknowledge in my writing, although I may not have always been. My powerful position does allow me a privileged location to look past and through the norm of girls’ experiences in school mathematics and set the goal of “legitimating their problems in the classroom” (Jones, 1992, p. 21), as well as legitimating their problems in the educational and academic arena. I want to provoke discussion and enable others working in the field of mathematics education to reflect on the difficulties faced by girls in mathematics in our schools as I agree that: “each individual should think deeply about his or her own beliefs and reinterpret knowledge about gender and mathematics in relation to these beliefs or assumptions” (Gray, 1996, p. 23). Many teachers may not like to be challenged on their personal ideas surrounding the mathematical education of girls. They may not feel that their pedagogies have any influence on the achievement, engagement and overall experiences of the girls they teach. They may not like the concept of a researcher telling them that they need to consider girls more and perhaps change they way they have done things in the past. I believe that research needs to be accessible, but more than that it needs to be relevant and modelled well.

Often research appears distant from teacher practitioners’ lived realities as “in most formal academic accounts of research, the arguments and positions of other theorists enter from above; as (usually) disembodied voices imported to add legitimacy to what the author is saying” (Jones, 1992, p. 22). I agree with the sentiments raised here as so many of the works I have read are “scholarly and complex” (Jones, 1992, p. 24) and the reading and interpretation
of their “density of style” (p. 29) can often inhibit the interpretation and knowing that comes from analysing the writing of academics. To initiate a change in mindset of mathematics educators and administrators any report on ‘girls and mathematics’ needs to be accessible to those who I wish to address. For me this means a shift to “include [my] explicit subjective presence in [my] writing” (Jones, 1992, p. 25). I need to show how the literature and research process has worked on my own positioning as a mathematics teacher and how this plays out in my teaching practice.

I will endeavour to protest against the patriarchal construction of girls in mathematics via the use of self-reflexivity. I will self-assess my own practices and experiences of mathematics striving not to just become another dominant voice speaking on behalf of girls. Jones (1992) eloquently describes a “politically just solution to the possibility of the oppressive feminist voice is for feminists to reveal our partiality, self-consciously exposing the particular theoretical/cultural spectacles which determine our view and shape our accounts” (Jones, 1992, p. 26). I cannot simply be reflexive, but must also examine and critically analyse the research literature and data to investigate the power relations in schools, what is happening to girls, and also what can be done/changed/improved.

The present discourse of school mathematics

This thesis invites response, dialogue and probably criticism, for daring to comment on girls in mathematics, when at the time the data was collected the political (and media) concern was the underachievement of boys in our schools. Girls were outperforming boys and subsequently the focus turned to boys’ disadvantage in educational circles (Epstein, Elwood, Hey, & Maw, 1998a; Watt, 2010). My view is that my data is not dated and irrelevant, a few years removed from the collection process, as my current experiences in the classroom, my conversations with colleagues within my school and in other New Zealand schools, as well as recent research literature, continues to remind me that all is not perfect for girls in mathematics classrooms. In my current school, far too many girls have been recently overheard saying they dislike mathematics and that they prefer their other subjects for me to ignore the findings of my research study.

Many authors around the – mainly Anglophone – world argued the case for boys (Biddulph, 1994; Bly, 1990; Connell, 1996; Lydon, 1996; Mills & Lingard, 1997; Sammons, Thomas, Mortimore, Owen, & Pennell, 1994). These authors suggest a range of solutions to the boy problem but lay the blame at the feet of women, that is, women teachers, mothers, feminists, or a combination of all three. In schools the main concern was boys’ under-
achievement but the popular media often failed to recognise that it is not all boys who were failing just as it was not all girls who are succeeding in all subjects. Success in school assessment does not automatically lead on to later success in the workforce. Achieving good results at school does not automatically result in advantages in the workplace (Epstein et al., 1998a) especially if the subjects where the successes are produced do not lead to careers with high potential for success and financial gain.

The danger in education is that when we focus on boys’ problems we marginalise the many issues still surrounding the education of girls in schools and their subsequent access to equality in their future tertiary education and employment opportunities.

Taking resources away from girls in order to give them to boys, who have always received more educational resources and continue to do so, is not likely to recommend itself as a solution to the problem of educating boys to those working with a feminist theoretical framework [and] to shift resources in this way would be unfair…because it is likely to be counter-productive, especially if used to increase, rather than challenge, the hegemonic masculinities in schools (Epstein, Elwood, Hey, & Maw, 1998b, p. 13).

Close analyse of available data has shown that it is mainly middle class girls who are now outperforming boys in high status, masculinist subjects such as mathematics (NZQA, 2010). These girls challenge the status of mathematics as a “recuperative, reactionary politics which seeks to reassert male dominance and traditional sex roles and in some manifestations is explicitly anti-feminist, even misogynist” (Mills & Lingard, 1997, in Mahoney, 1998, p. 38). Because some girls achieve at a higher level in mathematics there is now inaccurate reporting that all girls do well in mathematics. There is no public celebration of the fact that some girls can achieve well in mathematics but more an “outcry of anger” (Jones, 2000, p. 82) that they have over-taken boys in what has predominantly been seen as their subject area. Aside from this, there is no media discourse in New Zealand about girls’ disengagement with school mathematics and their withdrawal from the subject in senior schooling.

This thesis focuses on the issues that face girls in their day-to-day interactions and engagement with school mathematics. There appear to be a number of influences on girls and their experiences and choices of mathematics courses at school and later on at tertiary level. These influences, drawn from the literature (see Chapter Three), include the following:

• The structure and content of mathematics, that is the curriculum and how it is interpreted, taught, and how it positions girls as disadvantaged;
• How girls perceive parents’ and teachers’ views of themselves and their ability in mathematics;
• The way in which mathematics operates as a filter to future career and employment opportunities;
• How mathematics is positioned as a masculine subject, the hierarchies present within the structure of the school and the timetable;
• A lack of positive role models for girls in the area of mathematics and how girls feel they are unable to fully engage with mathematics as a subject and,
• Task differentiability within the teaching, learning and assessment of mathematics and the resulting gender differences in achievement, attitude, experiences and efficacy.

Paramount to my reflections and discussions is the realisation of the power of mathematics to impact on the future prospects of girls. Girls’ lack of participation has been linked to gendered patterns of participation in many tertiary and employment opportunities (Watt, 2010). Mathematics has a “mystical power to make and remake futures” (Kenway et al., 1998’, p.38) by limiting pathways to future employment in more female-dominated and feminine-typed occupations. Those in these occupations have been shown to experience lower pay and lower levels of job satisfaction (Watt, 2010).

Any changes that can be made to benefit girls’ access to, and participation in, school mathematics should also aid boys at the bottom end of the achievement and access statistics in mathematics. Strategies, which will change the way that mathematics is taught, learnt, assessed, and experienced should assist all groups in our society struggling with the power that mathematics holds over their life destinations in the future.

The research focus

Analysis of the research data where the girls locate themselves within the competing discourses of school mathematics have led to a focus on the following areas: mathematical pedagogy and mathematical space, the usefulness of school mathematics, and the emotions experienced as girls are positioned in mathematical discourses. Analysis of the data, informed by post-structural theory, suggets a need for further attention to the ways in which girls’ experiences of school mathematics influence girls’ subject choices. What is new about this research is that the girls also talk about their experiences of their other school subjects; contrasting these experiences with those in mathematics.

Many authors have written about space in the context of educational research (see Edwards & Usher, 2003; Gordon et al., 2000; Moss, 2004; Nespor, 1997; Opdenakker et al., 2002; Quinn, 2003). However, research in the area of mathematical space is sparse and the
purpose of this thesis is to investigate how mathematical space may impact on girls’ experiences, their learning, and their emotional enjoyment in secondary school mathematics classrooms by comparing their experiences with their other school subjects.

By investigating the concept of mathematical space, through analysis of mathematical pedagogies compared to those in other subjects, I am opening the door to consider how girls are positioned and constructed in mathematical discourses due to influencing factors controlled by others and by the environment they operate in. Hegemonic traditions and masculinised methods of teaching and learning may continue to influence the curriculum and teaching of mathematics, and result in disengagement of girls from this important school subject (Davies, 1996). The key focus of this thesis is to address the research questions; ‘What are girls’ experiences of secondary school mathematics?’ and ‘How do girls’ experiences of mathematics contrast with their experiences of their other school subjects?’

Organisation of the thesis

In Chapter Two, I discuss the underpinning theoretical framework for this thesis: feminist poststructuralism, to investigate the power relations faced by girls in mathematics. I describe how I will use it as a tool to position and frame my writing. I explain the poststructuralist views on areas used in the thesis including: discourse, binaries, positioning, voice, agency, experience and emotion. Chapter Three is a review of the literature on gender in mathematics with particular emphasis given to research of girls in mathematics, girls’ ways of learning and post-structuralist research in mathematics education. Different perspectives of space are also discussed, in particular, how it is used in educational settings. Chapter Four details the research methodology in terms of research design and data collection. It also includes detail of the pilot study and how that informed the final research process.

Chapter Five is the first of three findings chapters. Throughout these three chapters there are many contrasts given between the girls’ experiences of mathematics and their experiences of their other school subjects. Chapter Five explores the views of the girls in mathematics and describes how they experienced mathematical discourses. It examines the data with reflections on mathematical pedagogy, and the use of discussion, group work and practicals in mathematics. It also looks at the practical uses (or not) of school mathematics. Chapter Six looks at the girls’ views on how school mathematics is used. It examines the students’ perceptions of the usefulness of mathematics both in their present lives and in the future by examining discourses around assessment, credit accumulation and future career choices. Chapter Seven details the consequences of doing and experiencing school
mathematics and the often-negative impact on how students are re-constituted as a result of these experiences. It unpacks the emotions associated with doing school mathematics, their feelings about what makes a good teacher, and the competing discourses around their enjoyment of their other school subjects. Chapter Eight answers the research questions by presenting and discussing the conclusions of the thesis and the implications of these conclusions. The specific contributions the research has made to mathematics education are discussed along with the study’s limitations and opportunities for further research.
CHAPTER TWO: FEMINIST POSTSTRUCTURALISM

In this chapter I explain my choice of feminist poststructuralist theory as the underpinning theoretical framework for this study. Poststructuralism is a branch of postmodernism but with a particular emphasis on language (Lather, 1991). The categories of poststructuralism and feminist poststructuralism are often not adequate for describing the complex ways in which data can be interpreted, however, I like to think that St Pierre and Pillow’s (2000) idea of the “relationship we are working in and out of as feminist and poststructural, a relationship that gestures toward fluid and multiple dislocations and alliances” (p. 3) allows for multiple perspectives of what can often seem a complex or messy situation. Poststructuralist analysis of my data is a methodological tool that provides me with a method of critiquing my data through multiple lenses.

The key components of poststructuralist theory that I will consider in this chapter are: what is poststructuralist theory, feminist poststructuralism, the role of discourse, binaries (and their impact on everyday language and texts), subjectivity, agency, power and knowledge, emotions, agency, voice, positioning and experience. As I write my way through this chapter there will be considerable intersections in each segment. It is difficult to separate out the features of poststructuralism into concise divisions for the reader as there is intertwining of every aspect discussed. Poststructuralist work is often deemed to be too complicated, too theoretical, belonging to humanities and not relevant to education (Lee, 1992). I see mathematics education as very much a social practice and as such it lends itself to be looked at through the multiple lenses available in post-structuralist theory.

Poststructuralist theory

The origin of poststructuralism and poststructuralist thought is in the work of Jacques Derrida, Jacques Lacan and Michel Foucault (see Barrett, 1987). Derrida’s work focussed on the ‘deconstruction’ of ordinary meaning as he sought to dismantle the binary¹ logic in Western thought (Derrida, 1974). Lacan’s work looked at issues of ‘truth’ in discourse and ideas associated with the ‘other’, as well as, active, reflexive, and passive voice (Lacan, 1977). Foucault’s theoretical work centred on the notions of discourse; how social institutions are organised and how they influence the ways by which we come to ‘know’ anything (Foucault, 1972, 1980, 1988). Our experiences of the world are constructed through the meanings intrinsic in discourse/language. These meanings are generated by words and our

¹ Binary thought will be examined in more detail later in this chapter.
relationships with these words. It is argued that these meanings are in a fluid state, continually evolving and changing as our social realities continue to evolve and transform. This transformation is influenced by our readings and interpretations of discourse/language (Pilcher & Whelehan, 2004). The result is that social reality varies across cultures and time produced by this language.

Poststructuralism is difficult to define because of its pluralities. However, these same pluralities, or multiple readings of discourse, deny singular definitions and allow an evaluation of the “material possibilities” (Pilcher & Whelehan, 2004’, p. 113) available to, in my research, girls/women. It allows a discussion of how the choices that females make are often imbued in discourses, which are impossible or contradictory. Central to any discussion of poststructuralist perspectives is the concept of discourse: discursive fields, discursive formations, or epistemic shifts, some of which will be discussed later in this chapter.

Belsey (2002) says that poststructuralism is a theory, or a collection of theories, that concerns the relationships between humans, their world, and the exercise of making and reproducing meanings associated with that world. Poststructuralism allows for consideration and discussion of the multiple relationships that exist in any lived situation. “What poststructuralism offers is, in the end, an opportunity and a cause for reflection” (Belsey, 2002, p. 107). To understand and then discuss poststructuralism we need to examine humanism and how poststructuralism works to question humanist ideas of the world. There is a danger that in discussing humanism from a poststructuralist perspective that we can create a “binary opposition between poststructuralism and humanism that privileges poststructuralism” (St Pierre & Pillow, 2000’, p. 4). This is a very non-poststructuralist thing to do; poststructuralists aim to always show that there are multiple ways of interpreting the world and never wish to claim that they have the ‘right’ answer. Instead, the goal of poststructuralists is to open up a space for multiple interpretations and discussions.

Discussing humanism then becomes a difficult goal; therefore I need to acknowledge that any dialogue in this chapter about humanism is from a poststructuralist perspective. Humanism, as a mode of thought, came to be during the Enlightenment period of the eighteenth century where its roots were in critiquing Christianity or religion in general. Foucault (1991) wrote that humanism is a:

theme or, rather a set of themes that have reappeared on several occasions over time, in European societies; these themes, always tied to value judgements, have obviously varied greatly in their content, as well as in the values they have preserved. (p. 44)
It is a system of beliefs or a body of thought, which is today part of what we would commonly call “common sense” (Cherland, 2008’, p. 274). Another way of thinking about humanism is to see it as the way things are, that is, we see things in a particular way because we have always seen them that way. St Pierre and Pillow (2000) say, “within the discourse of humanism, it makes sense to say and think only certain things” (p. 4) whereas poststructuralists are interested in examining possibilities for new interpretations. Flax (1990) described many of the attributes of humanism in her writing. These attributes included such things as: viewing ourselves as a stable, coherent self, transparency of language, that reason can provide knowledge, that knowledge is true, and that “conflicts between truth, knowledge and power can be overcome” (p. 42). In humanism the subject is seen as the “rational, conscious, stable, unified, knowing individual” (St Pierre & Pillow, 2000’, p. 6), which is in contrast to the poststructuralist view of a subject that is constituted within discourse and social practices. St. Pierre and Pillow (2000) points out that this is where poststructuralism may come to our aid as it makes it possible for us to challenge and interrogate what humanism has taken for granted. Poststructuralism calls into question what we have come to see as normal and natural by showing that “discourses are not closed systems and that shifts in historical thought and material conditions are possible” (St Pierre, 2000 #304’, p. 4). Poststructuralism opens windows to new views on how everyday discourses are constructed and examined.

**Feminist Poststructuralism**

Poststructuralist analysis has allowed for a more “nuanced interrogation of the relations of power [that] has proved instructive and potentially transformative for feminists (Pilcher & Whelehan, 2004, p. 115). Bordo (1993) suggests that there are two accounts of Foucault for feminism and that they are reflections of one another. The first version relates to the “grip of systemic power on the body” (p. 194) and is a description attractive to many feminists. The second version is related to Foucault’s later appreciation for the “creative ‘powers’ of bodies to resist that grip” (p. 194). Both versions are important for our understanding of power relations and resistance. Bordo (1992) talks about the “postmodern marriage” (p. 167) between poststructuralism and feminism. She suggests that this ‘marriage’ provides a way to understand the production of girls in society, that is, how they are socialised and how oppressive patriarchal structures cause girls to be disadvantaged. Poststructural feminism is a branch of feminism, which uses insights from poststructuralist thought. Poststructural
feminism emphasises "the contingent and discursive nature of all identities" (Randall, 2010’, p. 116). It is also seeks to criticize the patriarchy present in cultures/society.

Jones (1993) writes that feminist research has traditionally focussed on girls’ disadvantage by thinking of girls as one homogeneous group. Poststructuralist feminists see the category of girl/women as limited because it for the most part ignores the differences amongst girls such as, for example, race and class. Traditional feminism overlooks the “contradictions and complexities in girls’ experience and particularly the divisions amongst girls” (p. 158). Jones argues that we need to simultaneously “use and reject” the term ‘girls’. She suggests that we need to concentrate on “differences/complexities within girls’ experiences” (p. 158) so as to avoid treating girls as a single category. Jones also believes that instead of positioning all girls as being disadvantaged in classrooms, by their experience, we need to focus more on how girls are ‘variously positioned’ in classrooms.

A poststructuralist might say that gender is an essentialist construct and as such it should be rejected. St Pierre and Pillow (2000) agree when they state that “poststructuralism provided a necessary and useful critique of practices of essentialism within feminism by offering theories to work against feminism’s tendency to generalize from the experience of white, Western, middle-class women” (p. 7). This allowed for identity categories such as race, class and gender to be challenged to acknowledge the complexity involved in the intertwining of these categories. Poststructural feminists are troubled by the very category “woman” and work to keep “that category unstable and undefined, open to...reconfiguration” (St Pierre & Pillow, 2000’, p. 7). Placing all women into one category may not allow for the differences within that group to be examined and might mean that the many complexities surrounding how women are positioned in society may be left unscrutinised or even completely ignored.

Some feminists believe that poststructural feminism has become a focus on language and discourse only. They question whether this concern with ‘texts’ has taken away some of the focus on the oppression of girls/women (see St Pierre & Pillow, 2000). Poststructural feminists believe that ongoing dialogue about the constraints of their work is actually desirable and, although this often contentious dialogue seems unexpected in feminist fields, (see Davies, 1997b; Jones, 1997) it makes sense in the poststructuralist terms of there being no absolute truth. Poststructuralists question any discourse or cultural practice; they ask, “How does it function? Where is it to be found? How does it get produced and regulated? What are its social effects? How does it exist?” (Bove, 1990, p. 54, cited in St Pierre & Pillow, 2000). Feminist poststructuralists do not aim to say that they have got it right, they are continually leaving themselves open for uncovering new truths and new opportunities for discovery (Davies, 1997b; Jones, 1993).
The role of discourse

Discourse refers to ways of constituting knowledge by considering social practices, forms of subjectivity and power relations that appear in these knowledges and interactions that occur between them. Discourses take us beyond traditional means of thinking and producing meaning. They “constitute the ‘nature’ of the body, unconscious and conscious mind and emotional life of the subjects they seek to govern” (Weedon, 1987’, p. 108) by examining the whole person within the contexts they present themselves in. In the field of linguistics, discourse is often described as ‘language-in-use’ or ‘socially situated text and talk’ (see Weedon, 1987). It is not about examining language as an abstract system but asking how written, oral and visual texts are used in particular contexts to make meanings. In other disciplines, including education, researchers tend to use the term discourse to mean what is ‘sayable’ or ‘thinkable’ about a topic in any particular setting (see Blommaert, 2005; Wetherell, Taylor & Yates, 2001) or as Belsey (2002) suggests “ideas are the effect of the meanings we learn and reproduce” (p. 7) and that the distinctions we make are not necessarily given by the world around us, but are instead produced by the symbolizing systems we acquire in a given context. Foucault (1988) referred to discourse as a system of power/knowledge, situated in a specific time and space. Discourse analysis centres on the production of knowledge, that is, that which is understood to be truth or reality. It asks what is sayable, for example, what is natural, normal, or unquestioned, and how it is sayable in each specific context. In this research, what is understood to be ‘normal ‘classroom discourse in mathematics classrooms will be questioned by examining the way students have come to understand how typical mathematics classrooms, learning and teaching are constructed in their school.

“Discourses do not merely reflect or represent social entities and relations; they actively construct or constitute them” (Walshaw, 2007’, p. 19, original emphasis). This is a reciprocal process where discourses are considered both the production of and the producer of the system or organisation. Discourse enters into and influences all social practices whether it be, for example, the overall schooling system in New Zealand or the individual practices of one mathematics teacher in a particular school. Humanistic discourse is seen as conversation, that is, communicating through talk in a simple and straightforward way. In poststructuralism, discourses are patterns of public and private language that reflect and also construct patterns of meaning (Weedon, 1987). Discourses are not closed systems. They draw on elements in other discourses, binding them into their own network of meaning (see Howarth, 2000):
“Discourse is not simple to define, but fundamentally refers to the organising principles of social institutions and how they shape the means by which we can come to ‘know’ anything” (Pilcher & Whelehan, 2004, p. 114). Discourse is about the production of knowledge through language, however, it is itself also produced by an exercise, called ‘discursive practice’, the practice of producing meaning.

Anyone deploying a discourse must also position himself or herself as if they are the subject of the discourse. This is because discourse makes it possible to construct a topic in a certain way but it also limits the other ways in which the topic can be constructed. For example, if the discourse of school mathematics is masculine/powerful/hard then this discourse may direct us to only examine it from this perspective as we engage with learners in mathematics classrooms. This may then limit discussion about mathematics to only one way of thinking and not allow for new ways of describing mathematics. Sometimes discourses are in conflict with each other as they reflect differing views of the world. They both reflect and create our beliefs about the world including forms of social identity such as gender (Gee, 1999) or as Britzman (2000) said:

Discourses authorize what can and cannot be said: they produce relations of power and communities of consent and dissent, and thus discursive boundaries are always being redrawn around what constitutes the desirable and the undesirable and around what it is that makes possible particular structures of intelligibility and unintelligibility. (p. 36)

Discourse can both empower and disempower; they sanction boundaries between what some can attain and what is unattainable by others. This sets up distinctions and divisions between who can take up certain powerful positions in our society and who cannot.

Foucault (1988) describes “discursive formation” as several statements working together. “The shifting loci of discursive formations allow for the emergence of oppositional discourses which may operate as marginal to the dominant formations, but offer the possibility of challenge” (Pilcher & Whelehan, 2004, p. 114). Examinations of such oppositional discourses in school mathematics, such as masculine/feminine or hard/soft, offer opportunities to challenge the dominance of discourses associated with school mathematics. As Weedon (1987) stated “power is exercised within discourses in the ways in which they constitute and govern individual subjects” (p. 113). As power is constituted in discourse this means that the meaning we have of a situation, for example, a female mathematics student, depends on how that student may be positioned socially, historically and politically (Walshaw, 2007). Examining alternative discourses thus has the potential to contest sites of hegemonic practice, that is, to confront, challenge and resist what has been seen as the norm.
In this project, that examination of alternatives comes in the form of looking at girls’ experiences of other school subjects and comparing them to their experiences of their, less enjoyable, school mathematics. What pedagogically works well in other school subjects sets up a challenge to mathematics’ educators to confront their normal practices and consider alternatives.

**Binaries and their impact on everyday language and text**

A binary or binary opposition is a pair of related terms or concepts that are opposite in meaning for example male/female or good/bad. What a binary does is position one side of the binary as more powerful or holding more power than the other side. A binary is a pair of either-or categories in which one category holds a privileged or hierarchical position over the other (Davies, 1997a; St. Pierre, 2000). Binaries, sometimes called dualisms, include pairs of terms found in everyday language and texts, such as masculine/feminine, hard subject/soft subject, rational/irrational (see Davies, 1989; Lee, 1992; Mendick, 2003). It is often difficult to imagine beyond a binary and, because of this definition where one of the binary pair must exist in opposition to the other, the power of one over the other remains intact. The suggestion is that if we look at binaries as “this” and “not the other” or “me” and “not me” then there is no place for an “us” (Bibby, 2010’, p. 22).

Humanism encourages this form of dualistic thinking where it presents us with sets of hierarchical opposites that take their meaning in relation to each other. “The essence of one is bound to the negation of the essence of the other” (Bibby, 2010, p. 22). This creation of binaries is problematic to poststructuralists because descriptors such as masculine/feminine only tell a small part of the story. Lee (1992) found from her research that investigating binary relations produced an “account of the extraordinary complexity and contradictoriness of gender relations as they are negotiated moment-by-moment in specific locations…the binaries might be best understood as initial points of structural intelligibility around which such an investigation could be constructed” (p. 2). Often the pairs of terms may seem uncomplicated, but when poststructuralists examine these terms closely they are able to look at how they have been produced historically in social contexts. The examination of binaries in this thesis allows for examination of how common discourses are played out in opposition to each other, and how these opposing pairs are gendered, favouring males or male ways of doing things over females and female ways of doing things.

MacLure (2003) explains how binaries are one of the most common ways that texts are constructed and refers to binary structures as “unfair pairs” (p. 10). Working within a
poststructural framework, there can be scepticism of binaries because their very nature means that they exclude as well as include. Frequently girls/women are the ones that have not been on the dominant side of the pair, and as such, they become excluded. Robinson and Robinson (2003) agree that:

one of the most powerful uses of discourse is to create pairs of opposite meanings which have the effect of either including or excluding individuals or social groups from the text, depending on the desired outcomes for that particular text. It is particularly important to note that one term in the pair is a dominant term, given preference over the other. (pp. 11-12, original emphasis)

This inclusion/exclusion based on who is positioned on each side of the powerful/powerless binary acts to construct individuals in society as either able/weak, competent/incompetent or dominant/inferior. This has unfortunate consequences for students (and teachers) in many schools. These binaries are often seen as linking to other distinctions such as whether a school subject is considered difficult/easy, useful/useless or hard/soft. For example, Abbis (2005) suggests that a lack of females in a class leads to the classification of a subject as being ‘hard’. If we consider arts subjects to be ‘soft’ subjects, because of a shortage of males in the classes, mathematics can be thought of as a ‘hard’ subject because girls opt out of the subject: “Hard is a relational term existing in binary opposition to easy, soft, and yielding, an opposition that parallels the associated one of masculine to feminine” (Mendick, 2003, p. 180, original emphasis). Mathematics as hard and difficult, and arts subjects as soft and easy, are the contrasting discourses constructing these curriculum areas. Mathematics is often seen as the “black sheep of the learning area family” (Davidson, 2008, p. 1) because it is perceived as hard, unenjoyable, and lacking in purpose. This binary is closely related to that used to describe gender: “Gender is constructed, through language, as two binary categories hierarchically arranged in relation to each other” (Davies, 1997a, p. 9). Viewing mathematics as hard and arts subjects as soft reinforces the domination of the male over the female and the rational over the irrational (Davies, 1997a).

The construction of the binary between arts subjects and mathematics places these curriculum areas in opposition to each other. The result of this is that girls who study both may need to ‘be’ differently in each subject. Davies (1997a) suggests that this binary ‘feminine/masculine’ coincides with ‘powerless/powerful’. It follows that girls studying both mathematics and arts subjects “illustrate the fluidity of gender and its socially and discursively constructed nature” (p. 11). What it means to ‘be’ a mathematics student can be incompatible with what it means to ‘be’ a student in the arts. As we will see shortly, this has implications for the kinds of subjectivities made available to girls.
These binaries are not always practical and constructive because they are complex and contain layers of contradictions. Instead, it may be more useful to think of them as tools for generating further discussion on how school subjects are perceived by students, teachers, parents and employers and how these perceptions may influence the status and subsequent ranking of one subject over another. Summarising the particularly complex set of relations that are put in play in this assembling of binary opposites is a difficult procedure. Even without a detailed examination of the gendered subtleties of classrooms the unexperienced eye can observe suggestions of the powerplays enacted in everyday classroom discourse. This gives powerful suggestions that all is not right with the underlying forces of gender dynamics (Lee, 1992). Examining binaries is a useful tool for examining classroom practices, however, this may often result in a complex and complicated view of the power relations of the classroom.

The most striking outcome…was the complexity and contradictoriness of the relations of gender power and privilege which were played out within the terms of these binaries. It is not a simple matter of equating the masculine side with power and the feminine side with powerlessness, as so many studies of classroom interaction and curriculum processes have done. The day-to-day negotiating of a position in the classroom on the part of teacher and students was a function of complex interconnections among these different binary categories. (Lee, 1992, p. 3)

Dismantling the binaries present in the discourse of mathematics classrooms may help to undo the power of mathematics itself. If mathematics is situated on the masculine/hard/rational side of the binary oppositions it holds a powerful position in the lives of students who attempt to engage with it. The data collected in this study will show many opposing binaries that confronted my participating girls in their experiences of mathematics and their other school subjects. To understand girls in mathematics classrooms requires a deconstruction of mathematics as it is perceived and lived. As Jones (1999) states the “experience of contradictions [are] important sites for gaining an understanding of the discursive constitution of selves as gendered” (p. 90). Understanding the binaries apparent in mathematics education allows us to understand how girls are gendered in mathematics classrooms and how this gendering influences their choice of whether to continue or not with the future study of mathematics. Davies (1989) says that girls become girls by partaking in the existing sets of social meanings and practices which define them as girls and the “available positions or ways to be (subjectivities) shift in contradictory ways” (Jones, 1993, p. 159). Girls can refuse to take up the subject positions and the discourses that make them inferior in mathematics, but how they could do this is unclear. A goal in mathematics classrooms could
be to expose the obvious barriers for girls, refuse the traditional ways which do not work for all girls, and look for ways of creating a new experience.

**Power and Knowledge**

What makes power hold good, what makes it accepted is simply the fact that it doesn’t only weigh on us as a force that says no, but that it traverses and produces things. It needs to be considered as a productive network which runs through the whole social body, much more than as a negative instance whose function is repression. (Foucault, 1980, p. 119)

Foucault (1980) was much more concerned with the effects of power than any explanations of how power worked or where it came from. He suggested that power is an underlying feature of all social relations. He also suggested that power threads its way through social practices and that it works in the lowest hierarchical situations, showing itself in many parts of our everyday lives. In mathematics education we need to look at how methods of power are exercised in everyday classroom discourses and how power is manifested by identifiable social domination of classroom practices. These spaces of power may be specific or quite diverse in appearance. Thinking about power in mathematics classrooms involves considering everyone and everything involved in the classroom. This means examining the discursive practices of the mathematics classroom. Walshaw (2007) states that “everyone in the classroom participates in a social web of power that allows him or her to develop as a learner (or a teacher) ... imagine then, power knitting the social fabric of classroom learning together and regulating its practices” (p. 67). Who or what controls whom and what and especially how this control mechanism operates needs to be untangled to show new ways that mathematics classrooms can operate where girls are not caught up in discourses that marginalise them.

Foucault (1980) proposed that power and knowledge were connected and in fact he went as far as to suggest, “far from preventing knowledge, power produces it” (p. 59). Power helps to distinguish what counts as knowledge and how that knowledge is constructed. Foucault suggests that the conservative idea that knowledge makes people more powerful and is good for them can be contrasted by the new thinking that “knowledge is something that makes us its subjects, because we make sense of ourselves by referring back to various bodies of knowledge” (Danaher, Schirato, & Webb, 2000’, p. 50). This idea allowed for explanations of how power enacts itself in the small everyday moments of our lives and how it is diffused in society. His belief is that power is part of the greater social body. That is why it is so hard to change aspects of power because it is not just simply a matter of wiping out one controlling
factor to make a change. Foucault (1980) stated that power “reaches into the very grain of individuals” (p. 39). In the mathematics classroom this means we need to examine so many contributing factors, for example, the curriculum, school governance, teachers and teaching, resources, the classrooms, parents and friends, and the students themselves. Every one of these relationships impacts on the power relations apparent in mathematics classrooms either directly or indirectly. Walshaw (2007) suggests that by using Foucault’s theories we are able to:

construct plausible explanations for how power operates even at the mundane and routine levels of everyday life. Yet observations aren’t likely to show up power operating through single one-dimensional arrangements. Instead, it would show power in networks that shift continually in a very unstable fashion, changing as alliances are formed and reformed. (p. 68)

The suggestion above is that power relations are complicated, volatile and constantly fluid making close inspection problematic. This implies that any research on girls and mathematics needs to be examined keeping at the forefront of any investigation that their experiences are constructed in spaces, through time and place, and within discourses that change continuously. Bordo (1993) states “power relations are never seamless but always spawning new forms of culture and subjectivity, new openings for potential resistance to emerge” (p. 192). The power of mathematics for girls is a fluid, social construct and this makes it difficult to make singular statements about what is happening for girls: there will always be a multiplicity of explanations. However, as Sawicki (1991) suggests even though the discourse (in mathematics classrooms in this case) is a “site of conflict and contestation” (p. 1) girls can “adopt and adapt language to their own ends” (p. 1). Sawicki suggests that even though girls/women may not have ‘total control’ over the discourse they are positioned in they must believe that neither do the boys/men. Girls may feel that to be ‘powerful’ in mathematics they need to take on the characteristics of a male learner, that is, they need to express themselves in a certain way so as to be ‘heard’. Girls may not feel comfortable to resist the dominant discourses they are presented with and so it is important that everyone involved in mathematics education understands the limits of the present discourses for girls and creates a ‘space’ for new ways of thinking and learning. Girls are situated within the discursive practices around them meaning they have to negotiate carefully through the spaces they are afforded and the spaces they are constructed within.
Subjectivity

Subjectivity can be defined as that “combination of conscious and unconscious thoughts and emotions that make up our sense of ourselves, our relation to the world and our ability to act in that world” (Crowley & Himmelweit, 1992’, p. 7). The notion of subjectivity captures the belief that individuals are purposeful subjects/actors in the world, but at the same time, as subjects, are exposed to forces beyond their conscious control that they may be unaware of. Language/discourse is considered the location where “actual and possible forms of social organisation and their likely social and political moments are defined and contested” (Weedon 1987, p. 21). However, it is also “where our sense of ourselves” (Weedon 1987, p. 21), labelled our subjectivity, is constructed. The production of such subjectivities occurs in a whole range of discursive practices within the economic, social, and political fields, and results in a constant struggle for power in each of these sites.

The terms ‘subject’ and ‘subjectivity’ are fundamental to poststructuralist thought (Jones, 1997, p. 263). Subjectivity is also described as the “modes by which, in our culture, human beings are made subjects” (Foucault, 1983, p. 208). The emphasis here is on the ‘process’ of becoming a subject and this process is considered one that is never complete (Butler, 1997). The concept of subjectivity demonstrates a “crucial break with humanist conceptions of the individual” as subjectivity is “precarious, contradictory and in process, constantly being reconstituted in discourse each time we think or speak” (Weedon, 1987, p. 32). Another view of subjectivity is that it is an “individuality and self-awareness- the condition of being subject- but understanding in this usage that subjects are dynamic and multiple, always positioned in relation to particular discourses and practices and produced by these- the condition of being subject” (Henriques et al. (1984), cited in Davies, 1991, p. 47). This is an idea that sees the individual as constructed in discourse (Jones, 1997). Subjectivity is perceived as constructed through ideology constructed in language and meaning where the individual may recognise herself but does not recognise the means in which her subject position is constructed. This may result in her assuming that she is the “author of the ideology which constructs her subjectivity” (Weedon, 1987, p. 31, original emphasis) rather than recognising her subjectivity was already produced within that same ideology. Subjectivity can be portrayed as “embracing both our physical experience of the world and our capacity to symbolise this experience” (Brown, 2011’, p. 6). The key components here are that subjectivity is about how we are constituted in discourse and then how we take up different positions associated with those discourses. “Human subjects are identified and identify themselves according to the positions they occupy within discourses” (Lee, 1992, p. 10). The
belief is that there space beyond or separate, either before or after, discourse. The individual is seen as unable to exist in isolation from the social constraints that impact on all meaning in their lived reality. Subjects are positioned in multiple ways because every location within society is a collection of various interrelated discourses. The implication is that “human subjects are multiple and fragmented entities, and social action is a complex process of negotiating a pathway through circulating discourses which produce the possibility of meaning - for the world as well as for the ‘self’” (Lee, 1992, p. 10). At the forefront of this activity is the power of language.

This implies that we are always outside of discourses like a stranger observing an unfamiliar world that we think is familiar. For girls in mathematics’ classrooms this may mean that they believe that how they experience mathematics is because of their own feelings about mathematics when, in fact, the mathematics itself may have constructed them in a particular way so that they have no other choice than to experience it as they do.

Poststructuralist theory suggests that it is in language/discourse that our sense of ourselves, our subjectivity, is created. Gee (1999) describes discourses as ‘identity kits’ and Davies (2000a) suggests that we ‘speak and write ourselves into existence’ through our use of these discourses. Walshaw (2007) uses Foucault’s idea that subjectivities are produced within discourses to propose that “the meanings that people produce are the result of political struggles and these struggles involve personal, psychic and emotional investments. These meanings have the capacity to both reproduce subjectivities and to modify them” (p. 18). Deconstructing the discourses of school mathematics opens up the potential to create a space to examine the multiplicity of subjectivities made available for girls in mathematics. Lather (1991) suggests that this type of action denies the view of there being only one true way forward. Poststructural tools allow a disruption of traditional discourses and a suggestion of alternatives to the current situation (Laws & Davies, 2000). Jones agrees “the language of discourse and subjectivity offer ways of talking about complexities and contradictions in understanding girls’ schooling” (Jones, 1993, p. 157), however Walkerdine (1998) suggests that several subjectivities are unavailable to girls.

One such position not available girls in school mathematics may be that of a brilliant/rational feminine subject. Davies (1989) and Walkerdine (1998) also emphasise how to ‘be a girl’ is about developing ‘feminine subjectivities’. If subjectivity is about who we think we are and who others think we are then we need to see it as in flux, changing over time, and determined by powers external to ourselves including the role of discourse. Often subjectivity is a “simultaneous mastery and submission, entailing a necessary vulnerability to the other in order to be” (Davies, 2006, p. 425). This draws on Foucault’s notion that an
individual does not invent a practice but rather that these practices are imposed on us via culture, society and social groups (see Davies, 2006), but it is a reciprocal process. Subjectivities are made available but we have some agency in taking them up. So what does this all mean for girls in mathematics? The notion of a girl in school mathematics, may be seen to be constituted outside what it means to be ‘real mathematics student’. There may be no “intelligible space” (Davies, 2006, p. 434) for some girls in school mathematics. Girls may have to “engage in performative acts” (p. 434) to have a sense of recognition in mathematics. What does that mean? For example, girls’ subjectivity in mathematics needs to be examined to see who they are and who we think they are in the mathematics classroom.

**Emotion**

In this section I discuss emotion with respect to educational settings. To discuss the research girls’ experiences I need to consider the characteristics of their emotions, that is, their feelings about aspects of their experiences at school in mathematics. I also need to consider how emotion is constructed in the discourses of their school experiences. The binaries of positive and negative feelings about mathematics (and their other subjects) are integral parts of the experiences of girls and influence how girls become positioned as learners in mathematics. Binaries, which include passion and enthusiasm versus disappointment and anxiety, act powerfully and impact on all facets of learning (Zembylas, 2007b) (Zembytas, 2007a).

Emotions are understood as “embedded in culture and ideology” or “embodied and situated” (Boler, 1999, p. xix) fixed in the discourses that surround us (Haraway, 1991). This makes emotions difficult to study and to draw out of the interview data as much verbalisation of emotion is positioned in personal and social constraints. Emotion is part of our everyday language, but is often hidden by nuances and kept hidden from the public sphere. There are many definitions, inconsistencies, and constraints when trying to define the word emotion where emotion is tied to such words as feeling and affect (Boler, 1999). I have chosen to use the word emotion to reflect feelings and all the words synonymous with feelings such as: sentiments, moods, reactions, impressions, responses, opinions, vies, beliefs, and attitudes. Using emotions also fits well with the often-noted binary construction of girls being emotional in contrast to boys being rational (Kenway & Youdell, 2011).

Emotional responses are often associated with girls and femininity whereas rationality is perceived as being a masculine trait and thus related to the ways of boys (Kenway & Youdell, 2011). If girls’ voices suggest that mathematics is too hard, or too boring, or not useful
without an acceptable rational reasoning to back this up then they could be constituted as irrational girls making them appear somehow weaker and inferior than those who can ‘do’ mathematics. This subjectivity produces a girl who if she is not rational or mathematical is not also ‘normal’. If mathematical spaces are positioned as rational, abstract, formal spaces then as Kenway and Youdell (2011) suggest, these formal spaces may be constituted as “uncontaminated by emotion” (p. 1320). It follows that if mathematical spaces are seen as no place for emotion then girls cannot show any emotion in mathematics classrooms.

Emotions may be considered as “inseparable from the situations in which they take shape” (Ria, Seve, Saury, Theureau, & Durand, 2003’, p. 220). They suggest that to describe any human experience it is necessary to consider the physical, mental, and social activities of the participants. At the same time there is a need to focus on aspects of their experience that are meaningful to them, namely, that they themselves can either comment on, tell, or show a researcher. There are three levels of emotion: immediate emotions which are situated in the now or the present moment, sentiments which are able to be told and commented on over time, and emotion-types where a typical reaction is in response to regular events (Ria et al., 2003’, p. 222). An immediate emotion in mathematics could be the reaction that an algebra problem posted on the board is frustrating. A sentiment might follow where the student tells the teacher or classmates that they hate algebra. They recognise that the problem is algebraic, but before they have even attempted to do the problem they decide it is too difficult because over time they have constructed this prior belief. The emotion-type reaction would be when the student sees that an algebra problem will always be hard because their past experience of algebra has made the student feel that they cannot do algebra because it is hard and that indeed they will never be able to do it.

Emotions have a strong relationship to disaffection with school mathematics (Lewis, 2013). The suggestion is that disaffection can lead to many concerns: the transfer of later learning, future participation in mathematics, equity issues and under-representation of some groups in mathematics and an aversion to mathematics in general. As mentioned earlier, it is not easy to characterise the term emotion/disaffection in research terms; however, Lewis (2013) suggests that we could think of it as negative affect or negative attitude or emotion. Another way of talking about negative affect is using the idea “quiet disaffection” (Nardi & Steward, 2003’, p. 349). The suggestion is that this is strongly aligned with low engagement with mathematical tasks and a perceived lack of relevance of the mathematics learnt at school. Affect and emotion are seen as being inseparable from thinking, including mathematical thinking (Evans, 2000). This suggests that there is a close relationship between the experience of learning of mathematics and the emotions felt during this learning. Unfortunately, for many
students, these emotions may be more negative than positive and the consequences are that many students in mathematics classes have negative experiences, which limit their progress, success and enjoyment of the subject (Lewis, 2013).

Disaffection in the mathematics classroom may express itself both actively and passively where the passive, non-disruptive, disengaged or even invisible students may potentially be lost as learners in mathematics because they can be too easily ignored or not noticed. Disengagement could result in emotionally withdrawing from mathematics in the classroom and then later physically leaving the subject completely.

Many students, even very able students, show emotions of fear and anxiety in mathematics classrooms resulting in them being damaged by their experiences of school mathematics (Breen, 2000). If we focus on emotion as a neurophysiological phenomenon then fear and panic appear as major emotional players (Caine & Caine, 2006). However, if we believe that emotions are hot, unstable and short-lived, that is, related to specific events then they could be viewed as more short-term (McLeod, 1992). Emotions in mathematics are related to specific outcomes in achievement opportunities (Pekrun, Frenzel, Goetz, & Perry, 2007) and to some extent the suggestion is that mathematical emotion is related to the goals that are set in the classroom (Andermann & Wolters, 2006). Success and achievement are closely associated to happiness whereas failure and disengagement align with the other side of that binary, unhappiness.

Emotion is often associated with anxiety and it is proposed that we need to understand that emotion alters in real time, minute by minute, in a classroom, and that it is important to understand how disaffected students become positioned in mathematics through their experiences and their own meaning-making of that experience (Lewis, 2013). Another suggestion is that emotional feelings, goals, and behaviours are at the core of all learning and that they adjust and alter regularly depending on what happens around the student in the space they become positioned in (Goldin, Epstein, Schorr, & Warner, 2011). It is also advocated that emotion is linked to engagement and that it has both behavioural and emotional components (Skinner, Furrer, Marchand, & Kindermann, 2005). If disaffection equals negative engagement then emotions such as boredom, anxiety, anger and shame coming to the forefront when a student is positioned as disaffected. Lewis (2013) links ideas of emotion with arousal, suggesting that ‘high arousal’ reflects feelings of anxiety and anger and ‘low arousal’ indicates a lack of stimulation or boredom and sullenness. Guilt is also an emotion that many students may feel especially when they do not pass in mathematics as was expected by others and themselves. This reflects Boaler’s (2009) notion of “brutal labelling” (p. 81) where students in mathematics experience declines in positive affect/emotion brought on by
being placed in lower-ability mathematics classes/groups after the results of summative testing. Positive emotions are also possible in mathematics: emotions such as pride and relaxation. Rises in affect are often correlated to a change in the space of mathematics such as a new teacher or a different approach to an old topic that was misunderstood earlier (Lewis, 2013). The new circumstances can give students a renewed sense of purpose and alter their otherwise fragile relationship with the old experience of mathematics. Relaxation comes to the fore after a student starts to believe they can cope with the work and can do the designated tasks with an absence of the previous anxieties. Pride follows if there is understanding and this leads to better achievement on a summative assessment.

It appears that emotions are a very complex issue to address as they are in flux, for most students they change from minute to minute. Understandings of what constitutes an emotion are problematic (Zembylas, 2007a). Many arguments are based upon the binary of nature versus culture and to what extent these contribute to how emotion is experienced and then communicated. It is important that researchers/teachers look for the cues that may indicate disaffection and listen to the voices of students when they state that they are bored or cannot do the work or do not want to do mathematics in the future. Understandably, this is difficult to do as emotions can be “largely internal feelings felt by an individual in relation to something that happens” (Zembylas, 2007a, p. 59) or something that has happened in the past or an anxiety about something that may happen in the future. However, the visible signs are important indicators and only by being receptive to these emotional responses can changes be implemented to transform these negative emotions into the more positive feelings of achievement, freedom, fun/enjoyment, control of one’s own learning, and feeling part of the group, in this case, the group labelled ‘those can do mathematics’.

Agency

Humanist thought sees agency as being about how individuals are formulated in relation to society and how society then acts upon them (Flax, 1990). This socialisation is seen as being done by a ‘hegemonic collective’, that is, influences such as gender, race, and social class are seen as fixed and that they become a part of the individual (Davies, 1991). The individual then can only make choices based on these fixed and rational ideas. Those on the dominant side of any discourse are seen as having the power to decide what is rational and anything else is seen as irrational or emotional (Davies, 1991’, p. 43). An example of this is where from my experience a male teacher who stands up for himself or his department in a
school is praised for being assertive, but a woman who does the same thing is defined as confrontational, emotional, or stroppy.

The poststructuralist concept of agency involves ideas such as there being no “essential self” (Davies, 1991, p. 49) and that an individual can only take up the subject positions that are available to them. We are never completely free to make ‘choices’, choices are made for us through discourse and any choices we do make are called “forced choices” (p. 46) because we can only choose/ use our subjectivity within the available discourses available at any one time. They are forced because there are always effects or consequences so we may feel as if we do not have a choice at all. We can only ever ‘be’ what various discourses make possible and one’s ‘being’ shifts with the various discourses as they are “spoken into existence” (p. 52). However, an individual has a presence and thus has access to subject positions where they have a right to ‘speak and be heard’ and through this they may become the “author of their own multiple meanings and desires” (Davies, 1991, p. 51) which allows them to ‘forge’ something new by using knowledge/experience of previous discourses to create new words and concepts and to imagine what might be possible.

The concept of ‘forced choices’ is for me one of the most difficult to understand. They are choices made according to someone’s ‘subject positioning’ within available discourses. The only possible action is seen as the ‘chosen line of action’ (Davies, 1991, p. 46). There appears to be no other line of action because the subject is ‘placed within the available discourses’ in such a way that they ‘want’ to choose that line of action. My own example of a ‘forced choice’ was while I was at secondary school. I was positioned as an ‘academic girl’ at that time in the 1980s when there was a huge push for more girls to move into the sciences (this in itself was a difficult positioning because my class background was very much working-class). I took this path even though I was better at arts subjects (and enjoyed them more). Eventually, I took up the more traditional vocation as a schoolteacher, albeit a mathematics teacher, as I still felt that my ‘choices’ were limited in the work force. There was also the perception that to do anything else other than teach would have been taking on the ‘male domain’ of science work. This fits with Davies’ (1991) notion of being ‘multiply constituted in discourse’ (p. 47) at any one point in time. I see this as where girls/women can move correctly in one discourse, but at the same time jeopardise their position in another discourse.

A focus in this thesis will be on how girls are positioned in mathematics classrooms. If we consider that girls are full human beings this allows us to recognise the agency that they have in the whole educational enterprise. By saying that girls are agents means that they can participate and act in complex social situations. Some girls may build different reasons to get
involved in school mathematics practices than boys. Their participation in those mathematical practices can be perceived as a whole social experience and not only as an intellectual, mental or cognitive undertaking (Valero, 2004). This may stem from their belief that they can use their agentic selves to influence the social space where the learning and teaching of mathematics takes place. In other words, girls become participants in a social situation, and the “development of that social situation depends strongly on the agency that they can exercise in it” (Valero, 2004, p. 48).

The concept of agency allows us to examine what autonomy girls have to assert themselves in the mathematics classroom: “Agency for learners is not about their forceful posturing in the classroom but rather about an awareness of the discursive restrictions and enablements made on them about what it means to be a learner” (Walshaw, 2007, p. 71). Foucault saw explaining agency in terms of freedom as an essentialist view that “fails to take into account how people actively and continually fashion their existence through the adoption of various and sometimes contradictory practices” (Walshaw, 2007, p. 76). Walshaw suggests that examining “discourses in action” (p. 77) may be more helpful as so many contradictions appear in the mathematical lives of girls. If we agree that we are “active agents capable of intervening in and transforming (within limits of course) the settings and institutions within which we live and work” (Walshaw, 2007, p. 114, original emphasis) then we agree that girls have the power to change their lived realities of school mathematics. To do this requires examination of the “constituting social relationships in operation” (p. 170) in classrooms and society in general. We need then to question the traditions, expectations and conventions associated with mathematics. We also need to remember and expect that girls may in fact accept and reproduce the hegemonies of school mathematics and use their agency to disengage from the subject, that is, using agency as a way to escape mathematics.

Poststructuralists reject the concept of the “subject as a fixed entity by denying any notion of essence at the heart of the self” (Pilcher & Whelehan, 2004, p. 112). Knowing oneself is believed to only occur through the medium of language, and “individual words themselves only gain meaning as part of a system” (Pilcher & Whelehan, 2004, p. 112). Girls may have accepted their position in the system and make choices that they believe they are happy to make. If they have agentic power to discontinue studying mathematics at school they may choose that path because that is the only path made available to them.
Voice

The unequal relationship that is constructed, between the ‘us’ who speak and the ‘them’ whom we represent, hampers any concerted effort to challenge those structures that historically produce the silencing of so many. (Matahaere-Atariki, 1998)

I intend to try to articulate the girls’ views and experiences of school mathematics with the goal of giving them a ‘voice’ in an educational system that purports to recognise, appreciate, and address the individual needs of all students. “[A] theme that informs many of the feminist perspectives [of research] is the necessity for females’ voices to be heard” (Campbell & Greenberg, 1993 in Gray, 1996, p. 21). I am assuming at this point that the girls I wish to give a voice to, do actually want to be ‘heard’. “It is possible that in “recognising” girls’ disadvantage in education we have also helped re/produce it” (Jones & Jacka, 1995, p. 165). In writing about girls, I have to take care not to construct ‘girls’ in such a negative way that all I do is continue to reinforce girls’ mathematics experiences in a language of disadvantage and thus constitute them in “particular and limiting ways” (Jones & Jacka, 1995, p. 167).

Judith Baxter (2003) discusses how powerful it is to use a range of different voices as sources of data. These voices can include the research subject, the researcher, as well as the theorists in a particular field. Baxter explores Bakhtin’s (1981) ideas on polyphony and heteroglossia to investigate the concept of “multiple-voices” (Baxter, 2003, p. 67). According to Baxter polyphony “involves providing space in an analysis for the co-existence and juxtaposition of a plurality of voices and accounts that do not necessarily fuse into a single authorial account” (Baxter, 2003, p. 67). In considering my research this means reflecting on the interplay of the voices of not only the girls but also their mathematics teachers, the Principal, and my view of what I saw and heard while collecting the data. Bakhtin suggests that each voice exists as being different to but also similar to each other, “utterances are not indifferent to one another and are not self-sufficient; they are aware of and mutually reflect each other” (Bakhtin, 1981, p. 60). This notion implies that even though the girls did not know I spoke to their mathematics teachers/Principal and gained their impressions of the girls in mathematics, the girls themselves may have constructed their voice not completely separate from the influence of ideas learned from their experiences in the classroom from these same teachers. Also, my prompts during interviewing the girls may have impacted on their voice in that they may have used my questioning to channel their responses in a particular way more in tune with what I wanted to hear rather than what they wanted to say. Baxter (2003) suggests that this makes it even more important for the researcher to take into account the “complex set
of possible understandings and readings of the data” (p. 68) and reflect on all the possible influences on the data collection and the construction of the voices of the research subjects.

Heteroglossia is the “act of making visible the non-official viewpoint, the marginalised, the silenced and the oppressed from other, more dominant viewpoints” (Baxter, 2003, p. 69). Relating this to my research, heteroglossia could be seen as a way to focus on the voices of my female participants in the subject area mathematics, which is socially constructed as being for boys. It also makes a space for these same girls’ voices at a time when the focus of disadvantage in schooling has switched to boys2 and their particular needs, suggesting that girls no longer have any of the problems in New Zealand schooling. The feminist poststructuralist viewpoint is committed to the continuation of a “spotlight and focus upon (especially) female voices and accounts of participants in a research study who may be relatively silent” (Baxter, 2003, p. 71, original emphasis). This silence may appear in contrast to the more “vociferous male or possibly female counterparts; or indeed to make space for voices which show evidence of having been repeatedly silenced by others” (Baxter, 2003, p. 71, original emphasis). When researchers and the media give more attention to a particular group, for example boys, they inevitably silence another group, in this case, girls.

With the current discourse of male disadvantage in schools (Francis, 2010a) and subsequent data released through the media that shows girls success at school there may continue to be a silencing of the specifics surrounding the ideas that girls still do not enjoy mathematics and even though they may have improved levels of attainment in school mathematics they prefer not to continue to study it when given the choice.

**Positioning**

Davies and Harré (2001) state that positioning is the “discursive process whereby selves are located in conversations as observably and subjectively coherent participants in jointly produced story lines” (p. 264). This sees us all as subjective beings holding multiple positions and engaged in diverse forms of discourse. When we speak or act from a particular position we are bringing to that position historical and social contexts from the world that we live in. Davies and Harré discuss two types of positioning: one where another person positions us, and the second where we position ourselves. They call these “interactive positioning” and “reflexive positioning” (p. 264) and suggest that these are not premeditated but that we produce ourselves in an ongoing process through our lives.

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2 As discussed in Chapter One.
Positioning is seen as a “conversational phenomenon” (Davies & Harré, 2001, p. 262) however; there are many types of conversation, and conversation includes verbal and non-verbal aspects of communicating. Above all though, positioning is a social construct.

Every conversation is a discussion of a topic and the telling of, whether explicitly or implicitly, one or more personal stories whose force is made determinate for the participants by that aspect of the local expressive order which they presume is in use and towards which they orient themselves. (Davies & Harré, 2001, p. 264)

This implies that by the telling of a story both the storyteller and the listener take up positions based on how the story is told, expressed, and received. Every story line in a conversation contains sections of a person’s autobiographical background entwined with the topic of discussion. Furthermore, a speaker can be positioned in a conversation by the subject positioning of another speaker in that very same conversation. This has many implications for the relationship between the researched and the researcher. For example, my research girls have a subject position in mathematics constructed through their experiences of mathematics during their lives. When I interviewed them they were also exposed to my subject positioning as a researcher questioning them about mathematics with aspects of my own personal experiences influencing my questioning of them and a subsequent focus on certain aspects of their conversations that were of particular interest to me and my research.

Davies and Harré (2001) claim that it is difficult to “produce a story of ourselves which is unitary and consistent” (p. 270) because our lives are full of diverse experiences which ultimately impact on the stories we tell. In making choices where there are conflicting requests there is a “complex weaving together of the positions (and the cultural/social/political meanings that are attached to these positions) that are available within any number of discourses” (Davies & Harré, 2001, p. 270) and the added dimension of the emotional meaning attached to each position.

These positions may develop as a result of personal experiences of being located in each position, or of relating to someone in that position; the stories through which those categories and emotions are being made sense of; and the moral system that links and legitimates the choices that are made. (Davies & Harré, 2001, p. 270)

We tend to experience ourselves in such a way that we believe that we have produced ourselves without any contributing factors. We take up discursive practices and narratives in our journey through life. We take them on board making them a part of ourselves. We own them, make them part of who we are and generate subsequent storylines that embody the
discursive practices that have positioned us. Mostly we are unaware that we do this, believing that our storylines are our own, that is, we assume that we produced them ourselves.

**Experience**

What is ‘experience’? Can experience ever be constituted outside of social relations? We do not think so. Each of us, though unique as individuals, are positioned within society, along hierarchies of power constructed around such factors as class, caste, race, gender, age and sexuality. (Brah and Hoy, 1990, p. 71)

Both of my research questions uses the word experience. I am interested in the experiences of my research girls in mathematics, in their other subjects, and their experiences of the ‘spaces’ available to them in their school subjects. This then begs the question “What is experience?” Ramazanoglu and Holland (1999) take experience to be “a loose, commonsense term referring to our own consciousness of our social existence” (p. 383). Experience is a multi-levelled system of understandings and beliefs about one’s life. How individuals experience their lives depends on the connections between all of the components and workings of their lives.

To analyse any taken-for-granted concepts of experience we need to examine the relationship between experience and social construction/positioning (see Usher, 1992). What we experience is closely linked to how we are positioned within existing hierarchies of power. Ramazanoglu and Holland (1999) suggest that although personal knowledge and experiences are connected to social interactions they may also limit knowledge because of the “wider networks of power relations” (p. 384) at work. Social relationships are shaped by the available discourses at any given point in time and because experience is seen as an embodiment, that is, a part of our own body, this means that because we live in different bodies we may also experience life in different ways. We express our experiences through the use of language and we make sense of our lived experiences in terms of the discourses available to us, however, we may not always be able to express ourselves and in fact be silenced because we do not share the same understandings as others or we may be limited by the language available to us. For example, the girls in my study may be positioned in mathematics classrooms in such a way that when they talk about their own experiences they are in fact telling a version of events that is deeply intertwined with the masculine hegemonies apparent in mathematics so that their own stories can never truly be their own stories; they are just telling the stories in a way that continues to reinforce the discourses they have learned to live with.
At this point, it is worth considering the difference between narrative and experience where the word ‘story’ may be used as a synonym of narrative, but can also be used to refer to the sequence of events described in a narrative. For me a narrative tells me what happened whereas experience may tell me why it happened. Freeman (1998) examines the difference between narrative and experience suggesting they are very different in that narrative is “an orderly and coherent tale with a beginning, middle, and end” (p. 456). He suggests that experience contrasts this because experience is messy, it is still happening and it does not end. Experience is often unstructured and difficult to constrain within ordinary explanations; it opens itself up for a vast array of interpretations. Experience is constructed from and within cultural and social impositions and is “infinitely plural” (Freeman, 1998, p. 457). Poststructuralist analysis of experience allows for the investigation of “shared meanings” (p. 457). Poststructuralists aim to unpack the multiplicity of life experiences and reconstruct a different type of story that may often be hidden in normalised societal constraints or as Scott (1992) says “what counts as experience is neither self-evident not straightforward; it is always contested, always therefore political” (p. 37). By unpacking the experiences of my research girls my aim is to look at the underlying messages behind their experiences and examine the societal constraints on these experiences.

Feminists who use poststructural approaches in their research utilise ‘storytelling’ as an interpretative approach to focus on the construction of individual subjectivity and agency by using personal accounts to explore an individual’s subjectivity in process (Benhabib, 1992). Storytelling promotes recognition of the relationships between multiple discourses and how these work to ‘position’ an individual to negotiate social and personal locations or “intertextuality” (Alice, 2003’, p. 66). Storytelling enables the exploration of relations at the “margin and centre” (p. 67) as well as recognising that there is diversity in the experiences of girls/women and that these experiences require attention. Scott (1992) criticises when others “universalize the identity of women” (p. 31) treating girls/women as a distinct group. Although there may be similarities in the themes from my girls’ stories, experience varies from girl to girl based on how they have been discursively constituted. It follows then that there cannot just be one cohesive reading of girls’ experiences of mathematics because of the “discursiveness of experience” (Stoller, 2009’, p. 723) that positions them in mathematics. However, there is a “commonness” (Davies & Davies, 2007’, p. 1143), which allows me to listen to my research girls and report on their stories believing that other girls, in other places have similar experiences because of the “common landscape” (Davies & Davies, 2007, p. 1143) of school mathematics which produces similar discursive positioning for girls in mathematics.
It is also important to acknowledge the “position of power” (Alice, 2003, p. 67) that any researcher brings to the research which may in itself position the researched in a specific way. Experience is ... always embedded in a field of experience ... this does not imply that everything is visible; the visible is surrounded by a field of the invisible. What I see ultimately depends on my own position within this field of experience. (Stoller, 2009’, p. 716)

It then follows that the feminist researcher must be wary of their own intentions, recognising that when they may think they are ‘empowering’ their research subjects they may actually be preventing the expression of views and ideas that differ from the intention of the researcher (Bowes, 1996). Furthermore, feminist research on experience is not always about empowering the subjects. I am interested in the experiences of my research girls to examine new ideas for how mathematics may be made more accessible for girls’ enjoyment of the subject. I am not necessarily empowering these particular girls but using their experiences, and my interpretation of their experiences, to make a space for new understandings about what may be right or wrong for these girls in mathematics and their other school subjects. “Experience is at once always already an interpretation and is in need of interpretation” (Stoller, 2009, p. 716). It is impossible to ‘see’ and ‘hear’ everything at once so the process of interpretation becomes tainted by the actual process of interpretation at any particular time, that is, “life continues to unfold in the accounting of it, and the account making is, in that sense, always a new event, a new experience” (Davies & Davies, 2007, p. 1141). As a researcher, my role is to continually disrupt taken-for-granted perceptions of experience and allow a space for new perceptions to be developed.

For feminists there is always concern with power relationships when examining experience data. Lather (1991) suggests that as subjects our knowledge and the knowledge of others has moulded us in a particular way. What we need to do is accept that our experiences are not closed off to the influence of societal beliefs and structures. Stoller (2009) sums this up nicely when she says, “whatever I see is always followed by something I have not seen” (p. 718) where she sees experience as inherently unstable but at the same time believes that this instability opens windows to new views and possibilities for change. We, the researcher and the researched, are both subjects of discourse, positioned in text and as such “we both have and are had by experience, “had” in the sense of being taken in and in a different sense, of taken in – taken in to the possibility of being” (Davies & Davies, 2007, 1156). To ‘be’ then, is partial and incomplete full of movements and multiplicities not one truth or false hood but an account of a particular performance produced and read at one moment in time. The texts produced from the telling of experience are “texts in motion, texts that produce moments.
of life as it is being lived; they form archives that enable us to study that production” (Davies & Davies, 2007, p. 1157) and allow for an understanding of how lives are produced and reproduced in complex ways.

Scott (1992) challenges conventional understandings of historical views of evidence by suggesting that these understandings are tainted by “hegemonic constructions of social worlds” (p. 24). She suggests that writing from the perspective of experience allows for a “corrective to oversights resulting from inaccurate or incomplete vision” (p. 24) by allowing the documenter to examine the direct practices of others by revealing their experiences, but also including aspects of the researcher’s own experiences to tell the stories. For many researchers evidence has been seen as real or the truth. It has been suggested that if the subjects’ experience has been used to back up any claims then this experience must be “uncontestable evidence” (Scott, 1992, p. 24). Questions arise about the “constructed nature of experience, about how subjects are constituted as different in the first place, about how one’s vision is structured- about language (or discourse) and history- are left aside” (Scott, 1992, p. 25). In this way the “evidence of experience then becomes evidence for the fact of difference” (Scott, 1992, p. 25). We can then use experience as a way of exploring how difference is created, how it functions, and how it constitutes subjects who “see and act in the world” (Scott, 1992, p. 25).

When I examine girls’ experiences in mathematics classrooms I am not just looking for how these experiences differ from their experiences in their other school subjects but also at how these differences have come to be: which structures in school and society operate to create these differences and how these differences work to create a different type of girl in these different types of classrooms.

For the researcher, whose role it is to theorise about lives and experiences, accountability may also be an issue. The researcher needs to be aware of whom they are representing and whose views they are presenting. Ramazanoglu and Holland (1999) regard the theorising of experience as problematic because it is “there, diverse and partially inaccessible” (p. 390) but believe that it is more important to explain any barriers to understanding experience than to simply ignore them. In other words, “taking experience seriously means taking responsibility for our own entanglements in power relations, and recognising that the experience of others can constantly disrupt our acceptance of what is the case” (Ramazanoglu & Holland, 1999, p. 391). Reflecting on experience opens a door for a greater understanding of inequalities in society and gives optimism that better explanations can be found.
Feminist Poststructuralism in my research

Poststructuralism offers “critiques and methods for examining the functions and effects of any structure or grid of regularity that we put into place, including those poststructuralism itself might create” (St Pierre & Pillow, 2000). Feminist poststructuralism allows for a closer interrogation of how power relations are played out in the patriarchal structures girls are faced with in everyday life and schooling. The supposed rigidity of poststructuralism can be replaced by the ongoing discussion and debate that feminist poststructuralism allows and hopes for. I will use feminist poststructuralism to continually trouble the humanist subject in discourse where the subject is seen as the rational, the conscious, and the stable being. I hope to look for new possibilities, new ways of understanding, and reinterpretation of what has always been regarded as the known.

Using feminist poststructuralism in this thesis allows me to be sceptical of different versions of authority and masculinities, but at the same time motivated to look for future possibilities that challenge the status quo. Feminist poststructuralism does not deliver final answers but prompts new ways of thinking by allowing examination of the uncertainties of my questions (Belsey, 2002).

My choice of a feminist poststructuralist framework will allow me to look at the social complexities inherent in my data and then attempt to work with it. It will allow me to examine practices because it aids in the breakdown of the oppositions that can occur between the social and the individual and allows the investigation of the relationships between these core aspects. Feminist poststructuralism theorises power relationships between the structures of social and individual relationships and will help to inform my research practice and scrutinise what I may have taken for granted in the past as a truth.

In the next chapter I look at girls and mathematics by reflecting on the research of others. This chapter will also include a section on poststructuralist writing within mathematics education.
CHAPTER THREE: GIRLS AND MATHEMATICS

In 1994 Sue Johnston suggested that choosing school mathematics is influenced by many factors including: perceived ability, attitudes of the students and significant others in their lives, the perceived usefulness of mathematics, and characteristics of the school learning environment. These influences are still very apparent in the more current literature. More recently research in mathematics education has examined the relationships that learners form with mathematics and their emotional responses and subjectivity with respect to the pedagogy, curriculum, and their positioning with respect to others (Black, Mendick, & Solomon, 2009).

Mathematics has long been seen as a ‘critical filter’, a ‘gatekeeper’ or a ‘powerful tool’ for limiting access to many future life choices academically and in the workforce (see, Gherasim, Butnaru & Mairean, 2013; Ma & Johnson, 2008; Reisman & Kauffman, 1980; Sadker & Sadker, 1995; Sells, 1978; Stinson, 2004; Walshaw, 2010; Watt & Eccles, 2006; Watt, 2010; Weist, 2011). Mathematics is identified as a key limiting factor to many prestigious careers resulting in many women not sharing in the advantages of those who are “mathematically well prepared” (Watt, 2010, p. 380). These careers offer access to different forms of communities and can result in greater social status and economic advantage (Cobb & Hodge, 2002).

This chapter specifically looks at the literature on girls’ experiences of mathematics. It begins by looking at the literature on under-participation in mathematics and how girls’ future life choices are limited when they choose not to access mathematics after it is made non-compulsory at school. This is followed by an examination of literature related to masculinities in mathematics, the influence of teachers, affect and emotions in mathematics education, the utility value of mathematics, and finally a review of mathematics education research conducted using a post-structuralist lens.

I have chosen to focus mainly on qualitative research associated with my study because I am most interested in what students have said about their experiences of mathematics in the research. The literature on gender and mathematics is sparse in New Zealand. Research in Australia and beyond, however, has many links to trends here in New Zealand and the implications from overseas research are important for our understanding of girls’ experiences of mathematics here.
Girls’ under-participation

In New Zealand, as elsewhere (see Cann, 2009; Charles & Bradley, 2009; Forgasz, 2010; Murray, 2011; Nagy et al., 2006; Vale, 2008; Watt, 2006), females are continuing to be under-represented in the higher level school mathematics courses, particularly at Year Thirteen of schooling. As discussed in Chapter One, there is a large decline in the number of standards entered by girls in Year Twelve and Thirteen mathematics courses. Although the gender gap in participation appeared to be closing around the turn of the century, there is now evidence appearing in studies to show that the gender gap is widening again in Australia and New Zealand (Forgasz, 2010; Vale, 2008). International studies in these countries have also shown that there is a trend towards achievement levels favouring males in mathematics assessments. In the 2003 PISA study, New Zealand males recorded more favourable results for each mathematics content domain (Vale, 2008). Results also favoured males in areas such as self-confidence, interest, and enjoyment. Girls only outscored males in one area, that of anxiety. The 2009 PISA results for New Zealand show that in the area of fifteen year-olds’ mathematical literacy boys outperformed girls at every level, although some of the results did not show any statistically significant differences in the scores between boys and girls.

Forgasz (2006a) has looked at enrolments at Year Twelve\(^3\) in Australia and shown that more males than females enrol in mathematics subjects that are pre-requisites for further study of mathematics at tertiary level. There appears to be a trend for girls to enrol in the lower-level mathematics classes at Year Twelve. Students in lower level classes often feel negatively about school mathematics and this may lead to many of these students opting out of future study of mathematics (Zevenbergen, 2003, 2005). There is concern that when the challenge is taken out of mathematics, which can happen in lower-level classes, the level of boredom and disengagement may increase and further contribute to a decline in participation (Brown, Brown & Bibby, 2008). In the Australian states of New South Wales and Victoria, data on the level of difficulty of mathematics courses and participation in these courses by gender shows that more boys than girls are in the higher level classes and more girls than boys are in the classes operating at the lowest levels in the final years of schooling (Watt, 2006). Data on the number of girls in lower-level mathematics classes in New Zealand is not available. Most schools organise their own mathematics programmes, and placements by gender is not data available by looking at NZQA results. There needs to be a closer examination of the specifics of participation in mathematics courses in New Zealand.

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\(^3\) Year Twelve is the final year of schooling in Australia.
Many girls do not consider that they are doing themselves a disservice when they opt out of school mathematics (Shannon, 2004); however, there may be implications for girls that they themselves may have not even considered. By avoiding mathematics at secondary school girls may unknowingly be making their very first career move (Sadker & Sadker, 1995). Girls “prematurely restrict their educational and career options” (Watt, Eccles, & Durik, 2006’, p. 295) when they discontinue with school mathematics. Data from a longitudinal study that looked at the gender imbalances in mathematics participation in senior secondary school showed a flow-on effect of more men in maths-related careers and the social importance of what is called a “waste of talent” (Watt et al., 2006’, p. 305). The perception is that girls then do not have successful careers in high status occupations later in life. Shapka, Domene and Keating (2006) consider this an issue for mainly unsuccessful maths students, but my previous work (Shannon, 2004) shows that even successful girls opt out of certain maths-related career paths. Research in mathematics education with a feminist focus has long been concerned about the ‘missing girls’ at all levels of education. Some girls gain mathematics qualifications but still chose not to advance into maths-related areas. By opting out they do not gain the “economic power and social status that maths confers” (Mendick, 2006, p. 140). Shapka et al. (2006) discuss the “prestige” or “social status or importance” (p. 348) associated with various occupations. Their work fits the binary construction of maths-related careers as prestigious careers and non-maths related careers as being non-prestigious. Many girls resent being told that they have made a wrong choice by opting out of mathematics. This positions girls as not having agency and not making wise decisions about what is best for their futures when they may have put a lot of thought and consideration into their choices (Mendick, 2006). Girls may feel that they are exercising agency even though this same agency may close down possibilities for accessing some prestigious careers. This then continues what is termed the “maldistribution of power” (Walshaw, 1999) in society.

Non-prestigious careers may include; teaching, law, and even medicine and dentistry: Careers which now attract large numbers of females, but which may still not be considered as prestigious as the more maths-related careers such as engineering or architecture. Research has also shown that females experience greater job satisfaction in male-dominated, masculine-typed occupations yet female numbers in non-traditional occupations continue to be low. Despite having equivalent achievement levels in mathematics, girls rarely aspire to high-status careers (Watt, 2010).

For many girls they are content with their career choices and may not consider they have missed out at all by opting out of school mathematics. Their choices are more linked to how they feel about mathematics and how they have come to dislike the subject, preferring to
stick with the school subjects that they enjoy rather than those they do not. Sometimes these feelings are related to their perception of mathematics as being a subject for boys, that is, a masculine school subject.

Mathematics is Masculine

For many people, and in particular girls, mathematics is seen as a boys’ subject (Blickenstaff, 2005; Francis, 2000; Kenway et al., 1998; Mendick, 2005). Unfortunately, popular media images of mathematics do little to stem this view. Moreau, Mendick and Epstein (2009) examine how mathematicians are portrayed in movies and television programmes such as A Beautiful Mind, Good Will Hunting, and Numb3rs. The mathematical geniuses in these are all male and regrettably they are also positioned as being odd, deviant, and lacking in social skills; not stereotypes that many people wish to be associated with, especially girls. Girls/women are often positioned as “successful but not succeeding” and “not belonging in the world of mathematics” (Solomon, 2012’, p. 171). By excluding girls/women from popular media this reinforces ideas about boys/men being good at mathematic and girls being bad at mathematics (Mendick & Rodd, 2009).

There is also the issue with mathematics as portrayed as a lonely occupation or a “solitary pursuit” rather than something that is done with others in a “community of enquiry” (Solomon, 2012’, p. 173). This may explain why traditional pedagogies in mathematics classrooms where students work in isolation are accepted as the norm. Mathematics may be seen as an “individual affair” (Stentoft & Valero, 2010) or an “individual performance-oriented pursuit” (Solomon, 2012, p. 173), something that you do by yourself to gain the best results you can. Another American television series has been shown in New Zealand titled Touch. This features a young child using mathematics in the form of patterns to communicate with his father. Once again this child is male, and in this case autistic, and unable to communicate verbally. These images of people who do mathematics, in my view, achieve nothing in the quest to advertise mathematics study as attractive to the general population as they reinforce mathematics as being for boys, and in fact for often lonely and weird boys.

Doing mathematics is also tied closely to images of intelligence or brainpower. Mendick (2005b) calls mathematics “the ultimate intelligence test” (p. 247) or another way of viewing mathematics is as a “cachet of intelligence” (Black, Mendick & Rodd, 2009, p. 49). If you are good at mathematics then it is often assumed that you must be intellectual, smart or gifted. However, if you feel like you do not belong, or are not accepted, or are failing then this may contribute to people just giving up. These binary discourses of belonging/not belonging,
accepted/rejected, and succeeding/failing create many tensions for students in mathematics classrooms (Williams, 2012). Epstein, Mendick and Moreau (2009) suggest that for young people, mathematics is still seen as the realm of the elite. The socially constructed view of elite is also closely linked to ideas of being male or masculine (Mendick, 2006). It then follows that if mathematics is for the elite, then it is seen as for males. Linking these ideas then sees mathematics as being for clever, bright boys. If we think of mathematics as being for boys then the other side of this binary is not for girls. Mathematics can then be seen as masculine and not attractive to girls. Ideas surrounding being bright conflict with girls’ ideas around popularity and often girls make “critical decisions” (Sadler & Sadler, 1995, p. 101) to opt out of mathematics based on views of mathematics as a nerdy or brainy subject. These discourses around mathematics being for boys do not only reflect social entities and relations but they continue to construct and constitute the very same discourse (Walshaw, 1999).

Mathematics is viewed as a male domain with associated masculine hierarchies that impact on girls’ everyday experiences of mathematics. Mendick (2005b) writes about the difficulty that many girls feel in taking on the masculinity of school mathematics. Two of her female participants actively deny their ability in mathematics. By positioning themselves as mathematically-able, they may fear that they are taking on masculine characteristics of being a nerd, a stereotype more associated with boys than with girls. Leder and Forgasz (2010), in their research of the public’s view of mathematics, found that a large proportion of those surveyed still thought that boys were better than girls at mathematics. Comments such as “Girls are always better at mathematics, Girls are good at English”, “Boys are better. They like to figure things out”, and “…boys. They are engineered towards mathematics- it’s a society thing” (p. 332-333) reflect many of the prevailing discourses of mathematics as being a subject for boys.

Females in New Zealand also rate their mathematical abilities as lower than males due to stereotyping of mathematics as a masculine subject (Alton-Lee & Praat, 2000). The suggestion is that because this stereotypical view is stronger amongst males, it is this male behaviour that deters females from participating and achieving in mathematics even when their ability suggests that they are quite capable of doing so. They also stress that the maleness of mathematics may be partially linked to many of the teaching contexts and materials/resources used by classroom teachers, especially at senior levels of the curriculum. There still seems to be an attitude of arts equals girls and mathematics/science equals boys. There is arguably a difference in status between mathematics and arts as summarised in the following:
This assertion of some sort of symmetry in the disadvantage caused by gendered subject choice seems blind to the clear differences in status between different subject groupings and fails to acknowledge the asymmetrical consequences in power and privilege associated with them. (Kenway et al., 1998, p. 73)

The irony is girls choosing mathematics are aiming high, whereas boys opting for arts subjects are aiming low.

The imposed hierarchy of mathematics which permeates society starts at school where “doing mathematics is very much about speaking ‘properly’: talking a particular style of masculinity” (Chapman, 2001, p. 200). As students move up the levels in school mathematics they are met with a subject that becomes much more abstract, precise, concise, and factual. Alienation from mathematics occurs because it is perceived as difficult, not enjoyable, boring, not needed, and not useful for life (Povey, 2010). Mathematics is often described as “disconnected, uninteresting and hard” (Shardlow, 2011’, p. 17) and it rarely invites creative and critical thinking. It lacks the ability to “arouse the spirit, cultivate the imagination, stir curiosity and invite further learning” (Shardlow, 2011, p.18), and because of this students may not cognitively engage with the learning process in mathematics classrooms.

Many girls perceive mathematics as something that should be useful in everyday living, but many view the mathematics they actually study as no help to them at all (Johnston, 1994). In my experience comments like, “When will we ever use this?” are common in mathematics classes, especially during abstract algebra lessons. Algebra receives many special mentions when students talk about how mathematics was “irrelevant”, of no “practical value” or not “real life” (Murray, 2011’, p. 278). However, students still feel that they should do mathematics, as it might be needed, because this is what they have been told constantly, that they cannot get a job without mathematics. As Sadker and Sadker (1995) wrote “girls are now learning the lesson that math matters, and the imaginary line once dissecting the curriculum is fainter, more permeable – but still there” (p. 122). As girls go through school’s senior years their “roads diverge” (p. 122) in what they need from mathematics compared with the boys and this is when they drop out.

The “theme of lost opportunity” (Murray, 2011, p. 270) contrasts this in some ways because Murray’s students expressed anxiety that if they had been told earlier how important mathematics really was they might have tried harder to engage before it was too late. Some believed that mathematics was so important to their futures that it should be compulsory so that they have no choice, but to just get on and do it even when they can see that it is a subject not suited to their ways of thinking and learning.
This could be because mathematics provides an arena for male methods of speaking/thinking to occur:

Proper hard, non-subjective subjects like maths…provide a haven of acceptable (male) knowledges which confirm that true knowledge lies outside oneself and independent of any subjectivities, independent of those emotions which need to be held in check. They are rational, cool, controllable, abstract, distinct, and unquestionably hegemonic. (Davies, 1996, p. 214)

The reputation of mathematics as being hard is partly related to it sharing many of the same features for which males are valued. These characteristics include it being “potent, authoritative, determined, demanding, and willing to take the grandview” (Shaw, 2009, p. 114). Pure knowledge or decontextualised knowledge, as experienced in many school mathematics classes, marks mathematics as masculine and gives it higher status than many other subjects (Paechter, 2000). Girls may be subjectively positioned as learners with emotional needs and in need of softer, easier subjects at school. This then positions girls as outside the realm of those who can do mathematics because they are constantly constructed in opposition to the discourses associated with what is real mathematics.

School mathematics is an “inherently gendered discourse” (Chapman, 2001, p. 201). This makes it difficult for girls to “take up and maintain a role as a mathematics student” (p. 210) because to do so they are required to speak/act/follow rules in a particular way that may not be suited to their own intrinsic methods of learning. Purser and Wily (1992) suggest that all students “prefer to see the connection between the maths they do and the lives they live” (cited in Forbes, 1996, p. 80). I argue that context is important to all students, and participation in mathematics may be seen as a more socially valuable experience if the contexts are realistic and relevant to all learners. Pulling mathematics down from its top-of-the-hierarchy perch as a masculinised subject will benefit all learners in mathematics, not just girls.

For girls to consider mathematics as a viable option, they need to not only have access to appropriate courses that will benefit their future options, but they also need to perceive mathematics differently. Some common discourses associated with mathematics are; “geeky; difficult; a symbol of intelligence; a source of power; dry and irrelevant; fascinating and abstract; and a refuge for social misfits” (Bartholomew et al., 2011’, p. 920). These characteristics may not be appealing to all girls and they may not like being positioned in such a way just because they study mathematics. Girls need to believe that mathematics is a subject for them, not one that works against them.
It has been noted that there is a lack of affective or emotional dimension in mathematics (Nardi & Steward, 2003). The list of negative perceptions of mathematics includes; tedious, isolated, rote learning, elitist and, de-personalised; suggesting that mathematics does not engage or inspire students and that many teachers focus on teaching to meet the needs of assessment rather than teaching for learning. Often assessment tasks undermine any attempts to change pedagogies of mathematics so that opportunities to investigate, discuss, reason or generalise are abandoned to accommodate the need to prepare for an assessment (Walls, 2010). Pedagogical devices are complex and influenced by many factors such as the authority of a test/assessment, relationships between teachers and students as well as relationships between students and students. Often there are many underlying discourses at work that impact on the learning environment (Calder & Brown, 2010). A female student, in Brown et al.’s (2008) research on reasons why 16-year-olds in England do not continue to study mathematics, said, “I enjoy subjects where I can express myself like English” (p. 9). This is linked to ideas that mathematics is often seen as boring and lacking in opportunity for creative expression. For many girls, creativity is important, and traditional methods of teaching as experienced in many mathematics classrooms do nothing to stimulate them and position them in a positive way in mathematics classrooms (Shannon, 2004).

For many girls mathematics is not seen as real world, that is, it is esoteric and has no relevance for their future. There is a myth that mathematics at school is valuable and transferable to everyday practices and uses (Christiansen, 2007); however, discussion about the usefulness of mathematics in everyday life or to students’ futures is noticeably absent in classroom discourses (Christiansen, 2007; Forgasz & Leder, 1996). The real world is only apparent in the context of some tasks and an abundance of male-stereotyped task contexts, such as about building, cars, or male sports, subtly conveys messages that mathematics is only relevant to the future of males. Often students see mathematical skills as valuable, but when asked to provide examples of where they might use mathematics outside of the school classroom they cannot provide any examples (Davidson, 2008). There is no guarantee that students will engage with mathematics just because they are provided with a teacher, teaching materials, and a mathematics classroom (Stentoft & Valero, 2010).

Murray (2011) examined why students did not continue to participate in mathematics when it became not compulsory and she asked them to suggest solutions to the problem of under-participation. In order of most common response, the following reasons were given: that mathematics was difficult, that it was irrelevant and not ‘real life’, and that it was not taught well. Some of the solutions to the retention problem were: make mathematics more interactive, fun, and hands-on; for teachers to ensure that students genuinely understand
mathematics; and those teachers to ensure that their students understand how important mathematics is for their futures. Interestingly, the students themselves thought that interventions needed to take place much earlier in their mathematics careers and that mathematics should not be an optional subject at all at school. Leder and Forgasz (1996) also found that two thirds of their respondents agreed that mathematics should be studied even when it is no longer compulsory with one person stating: “Absolutely. It opens up a lot of career paths and shuts doors if you don’t” (p. 332).

In my earlier work (Shannon, 2004), I noted that mathematics problems seem to fluctuate from one end of a continuum to the other, where at one end there are questions with just numbers and at the other end real world problems with mainly masculinised themes. Jo Boaler’s work (2002, 2009) reiterates this. Firstly, she argues that “pseudo contexts” (Boaler, 2009, p. 47) are of no value as often they are not realistic contexts for the students trying to engage with the problems. Boaler suggests that the only valuable contexts are those where students are involved in mathematical analysis of a particular situation where the variables posed are integral to the solving of the problem. Boaler (2009) also suggests that students, especially girls, want to discover and work with mathematics in a way that allows them to see how it “fits together” (p. 37) rather than experiencing mathematics as a series of disjointed parts taught in bite-size snippets. When mathematics is presented in decontextualised parts it is very difficult for students to gain the mathematical literacy, which allows them to handle, for example, numerical or spatial situations outside of the classroom (Christiansen, 2007).

Comments such as “maths is just like it’s all numbers” (Davidson, 2008) reinforce the view that European middle-class males have for centuries defined mathematics in their own terms and around their own notion of mathematics as ‘disembedded thought’ (Boaler, 2009; Mendick, 2006; Willis, 1990). Mathematical disembedded thought does not value the incorporation of relevant context into problems. For many students disembedded or context-free thinking is a major stumbling block (Lyle, 2000). However, the belief is that disembedded thought is essential for success in the educational system as it stands because, although difficult, this type of thinking is what is valued in assessment, for gaining teacher approval and for high-level attainment (Lyle, 2000). For many students, particularly girls, their backgrounds, daily experiences, culture, or lived realities are ignored to maintain the power of mathematics as a male domain. One view is that the mathematics curriculum and mathematics teaching should “encourage critical thinking and promote agility in thinking, the taking of initiative and the development of curiosity and imagination” (Sharlow, 2011’, p. 18). When students see mathematics as just a lot of dumbed-down problems or mindless calculating it is no surprise that they become disconnected from mathematics and find it
boring and hard. Students have learnt from their experiences of school mathematics that they will be faced with many unusual problems in class that have no relationship to their realities. A lack of “real or authentic everyday mathematical situations” (Davidson, 2008, p. 7) in school mathematics ensures that mathematics lacks purpose, significance, and value for many students. They have come to realise that if “they think about the problems and use what they understand from life then they will fail. Over time, schoolchildren realise that when you enter *Mathsland* you leave your commonsense at the door” (Boaler, 2009, p. 45, original emphasis). They are forced to interrupt reality and enter a mathematical world devoid of any relationship to what they know and engage with a subject that presents itself as meaningful but, in fact, is not.

We are told that learning mathematics will result in a gain in power but that power exists not in the mathematics but in the ‘myth of mathematics’ (Christiansen, 2007; Ernest, 1998; Leder, 1990a; Willis, 1990) through its prestigious position as an elitist intellectual discipline which separates and represses many women from accessing the ‘silver spoon’ club of the mathematically talented few. Mathematics is positioned at the ‘pinnacle’ (Shaw, 2009) and the suggestion is that it has become unassailable and out of reach for many. The grip it has on being constructed as powerful and glorified has also caused it to become a place of “negativity and destruction” (Shaw, 2009, p. 111), which results in mathematics being rejected by many. The maleness of mathematics permeates society and irrespective of how mathematically competent girls/women are it is difficult for them to avoid discursive practices that construct mathematics as a male domain (see Damarin, 2000, 2008). Most Australian students no longer stereotype mathematics as a male domain (Goos, Stillman & Vale, 2007), however, I would argue that if girls are still disengaging from mathematics then there are still serious problems with school mathematics. Goos et al. (2007) do accept that girls are not as positive about their mathematical abilities and that participation rates in advanced mathematics classes that prepare students for tertiary study show strong gender differences where fewer girls are participating. Of concern is that many mathematics teachers are female and yet this does not often seem to help some girls in their learning, as it appears that mathematics is taught in the same ways irrespective of the gender of the teacher.

For girls to feel accepted into its realm, mathematics and mathematics pedagogies need to change. Mathematics needs to reflect the backgrounds of all students who study it and it needs to provide a comfortable space for the engagement and enjoyment of all students. An acknowledgement of the contributions that girls can make to mathematics learning needs to be considered with reference to the environments they are placed in and how they come to be positioned as learners (Boaler & Sengupta-Irving, 2006). We may need to look not only at the
space that surrounds them but also carefully consider the spaces they already occupy (Mendick, Moreau & Epstein, 2009). The spaces provided for mathematical learning are complex environments. Mathematics is positioned as a result of the many contradictory discourses that surround it, creating boundaries that exclude many learners. In the next section, literature related to space in education, in general, and then mathematics is examined.

Classroom Space in Mathematics

Recently ideas about space, place, and time have been considered in the field of education and in particular the context of schools, their grounds and their classrooms. Many girls may experience their mathematics classrooms in different ways according to their expectations, which are based on past knowledge and experiences of mathematics classrooms and how they have come to be positioned within mathematical classroom discourse (Holloway & Hubbard, 2001). They understand from their positioning that what happens in mathematics happens because it is mathematics, and can identify how mathematical spaces are experienced in different ways to their other school subjects. Mathematics teaching and learning are located in discourses, which are themselves “situated within institutions, historical moments, as well as social, cultural, and discursive spaces” (Walshaw, 2010, p. xi). Descriptions of space are now closely linked to the environments being investigated as well as the relationships apparent within these environments (Gherasim, Butnaru & Mairean, 2013).

Many considerations about space are concerned with physical space, however, social, behavioural and metaphorical space have emerged in the literature as researchers recognise that space is more than just physical locality (Harvey, 1996; Massey, 1992; Rose, 1993). Linked to these emerging areas of social and behavioural space are issues of people’s subjectivities and positioning, and their relationships with other people, that is, the power relations that operate in everyday spaces (Holloway & Hubbard, 2001).

Defining space

The defining of space as a concept has proven to be difficult and many authors and as such it is easier to think of space as an evolving, fluid idea. Space is an ambiguous concept that is “open to highly contested interpretations” (Moss, 2004, p. 291) and it is difficult to define space without using the word space. Concern about what the term space actually means arises from the very fact that there are a “multiplicity of definitions” (Massey, 1992, p.66) in use. Many authors “rely heavily on the terms ‘space’/’spatial’, and each assumes that their meaning is clear and uncontested” (Massey, 1992, p. 66) but, as I have realised from my
examination of the space literature, definitions and descriptions vary greatly mostly dependent on the theoretical standpoint of the author and on the particular message that they are trying to voice.

Many descriptions of space are scientific, rational explanations of the idea. They use technical language such as density, expanse, and interval, and are related to scientific principles. In contrast, the conceptualisation of space in the social sciences “runs counter to notions of space and time within the natural sciences, and most particularly physics” (Massey, 1992, p. 76). The physics’ view of space as a “passive arena” (Massey, 1992, p. 76) suggests space, time, and objects exist in their own right detached from each other. Arguments against this view suggest: “space and time are inextricably interwoven” (p. 770). Space can be conceptualised as a result of the interrelations between space and time suggesting it is “not absolute but relational” (Massey, 1992, p. 77) and it is “not that the interrelations between objects occur in space and time; it is these relationships themselves which create/define space and time” (p. 79, emphasis in original).

In defining space it often “slips through our fingers” (Quinn, 2003, p. 449) and the “most useful definitions of space are those that evoke such intangibility, but recognise the limitations and constraints enacted within space…” (Rose, 1993, p. 34). Space is difficult to define or describe clearly, but it is nonetheless perceived, an unquantifiable quality or asset, that is often not able to be touched or seen making it a word/concept almost without a material basis. Space is not a transparent concept, which suggests that it is difficult to unpack the ideas surrounding space and its use and explain them. Most conceptions of space have used rational explanations that are inadequate to explain how people interact in specific places and the suggestion is that when we talk about space that we need to include how space is used socially (Quinn, 2003).

Space has been characterised as being not a fixed “identity of place” (Massey, 1994, p. 169), as being in flux, always changing and as a “construction, rather than an immutable fact” (Quinn, 2003, p. 460). Geographers have always contested that space is a quantity that can be mapped and that they understand it as “absolutely knowable” (Rose, 1993, p. 38) and that its transparency signifies an innocence that can be readily accessed and that what is seen is what is really there, a predictable truth viewable to all. “Paradoxical space” (Rose, 1993, p. 159) is how space is represented in a way that is visible but not really known and this is bound up with the material limits imposed by a particular space. However, in contrast, Quinn (2003) warns against considering space as a fluid commodity. We cannot assume that space is an indifferent, fluid medium. It has boundaries, which have important roles in how subjects
move within a space, and at times may even make it impossible for movement to occur (Pile and Thrift, 1995).

Thinking of space as intricably tied to boundaries and limits allows us to contemplate what happens when we step outside those boundaries of a designated space. As soon as we acknowledge that the movement outside of and back into a space can happen then it can no longer be designated as a stagnant entity. This allows us to think about how to access spaces where there are dominant structures in place limiting entry for all, such as courses and classrooms in schools where girls may not feel comfortable.

Three conceptions of space include: ‘spatial practice’ as perceived space, ‘spatial representation’ as conceived space and ‘representational space’ as lived space (Lefebvre, 1991). Perceived space can be thought of as superficial, outwardly observable but appearing markedly different to individuals. Conceived space is imagined space, that is, how an individual envisages a space should be and lived space is the space as it exists and is inhabited. For many students at school they may experience classroom spaces depending on how they expect that space should be constructed rather than as it exists.

Space is a problematic concept and currently there is a movement towards a metaphorical use rather than an analytical one (Gordon, Holland & Lahelma, 2000). There are three aspects; physical, social and mental. Physical space is considered to be a ground-level space restricted by the boundaries which constrain it but without the energy present in a space there may be no reality to that space as society “produces a space, its own space” (Lefebvre, 1991, p. 31). This suggests that that the “social production of space create margins and centres through differentiation and domination based on…relations of power” (Gordon et al., 2000, p. 18). If space is socially constructed but also constructs social relations then it appears that some spaces may be more restricted/restricting than others and that access to these spaces may be limited due to the consequence of complex social power relations.

**Power relations in space**

Space may be deeply implicated in the production of individual subjectivities and social inequalities (Shilling, 1991). Mental space refers to the “imaginary and symbolic” (Gordon et al., 2000, p. 19) and this notion may be connected to the masculine view of the world. How people are positioned in space is “created and recreated” (Gordon et al., 2000, p. 19) by men and may restrict which spheres are open to women. The mental space is a place inhabited in the mind similar to Lefebvre’s representational space, a space perceived to be closed but which may in reality be a place for alternative versions of the use of that space.
In considering aspects of space and spatiality issues of bodies and embodiment are raised. Aligned with space is the concept of organisation and control or as Massey (1992) writes “space is by its very nature full of power and symbolism, a complex web of relations of domination and subordination, of solidarity and cooperation (p. 81). Who has control and decides on how space is utilised and organised is an interesting question in the field of education. Paechter (2003) says of the educational organisation of school space that “space matters, in more ways than initially meets the eye” (p. 42). Shilling (1991) acknowledged that “the study of space should be integral to analyses of the relationship between educational differentiation and social reproduction” (p. 23). She outlines Gidden’s theory of structuration and suggests that space is essential to structuration theory. The structures, redefined as ‘rules and resources’ are used in “specific spatial contexts” (p. 24), these contexts effecting the (re)production of many features of society such as gender inequalities. This is because space provides opportunities for people to act (use rules and resources) in some situations but in those same settings it may constrain the activities of others. An example of this is how teachers and students use the same space in a classroom, or how girls and boys use the space provided in a mathematics classroom.

Multiple positioning of students in schools is tied to space and spatiality and that social difference, including gender, are “played out by bodies in space” (Gordon et al., 2000, p. 137). Space is integral to the production of disparate gender relations in schools. However, power relationships between teachers and students are constructed as aspects of space in classrooms are used by teachers to demonstrate their power and authority over students (Shilling, 1991). “Power and the organisation of bodies in space are interactively linked” (Edwards & Usher, 2003, p. 3) where spatial ordering contributes to specific forms of learning and subjectivity. It is not useful to focus only on physical and material spaces as “people interact with each other and objects in space and in so doing construct, disrupt, and resist meanings and understandings” (Edwards & Usher, 2003, p. 5). The distinction between “the body as a generator of space and the body as an object in a space” (Nespor, 1997, p. 121) describes how our experience of a space depends on the view that we have of it and of others in that space. Once again the focus is on social space and the resulting interactions and relationships within it.

Many feminist writers believe that not only is space constituted through social relations and practices but that the social is also “spatially constructed” (Massey, 1992, p. 70). This follows the work of Bourdieu (1997) who pointed out that metaphoric meanings are not an intrinsic part of the organisation of space, but have to be brought into play through the activities of social actors. When examining issues of gender in relation to space Massey
(1992) shows how often “conceptualizing space and time takes the form of a dichotomous
dualism” (p. 71) or what I have discussed elsewhere as a binary construction. This
dichotomy/binar is based on the presence or absence from a designated space or time. She
believes that space defined as absence or lack of or negativity maps onto the “constructed
dichotomy of female and male” (p. 73) and is thus understood as female because often in
western culture woman is defined in terms of lack. This can be taken even further to propose
that when space is aligned with stasis it is “coded female and denigrated” (Massey, 1992, p.
74). What this may mean is that spaces with fewer woman/girls in them are positioned as
masculine and therefore more powerful, whereas, spaces with more females are positioned as
areas of weakness. In terms of school subject choices and classrooms this may impact on
perceptions of which school subjects are for boys and which are for girls.

Space in the School/Classroom

Socially constructed spaces contain many metaphorical contexts (Laclau, 1990; Massey,
1992). I believe that the notions of presence and absence can be physical or metaphorical. A
physical presence/absence meaning to be/not be bodily in a place such as a school classroom.
A metaphorical presence/absence relates to being bodily in a space, but not actively involved
in what is going on in that space. An example of this could be a girl being in a mathematics
classroom but not actively engaged in the class activities, classroom discourse, or interested in
the curriculum work taking place. In this way she would be physically present but
metaphorically absent. This is reiterated in the statement: “in space you can go off in any
direction and … in space things which are next to each other are not necessarily connected
(Massey, 1992, p. 82). Students may not be connected at all to the teacher or the curriculum in
a classroom but exist in their own space isolated from what is happening around them.

Studies on quiet students in classrooms have shown the relationships between verbal
and physical space in classrooms. Students’ “perceptions and experiences of the lived peer
culture, the curriculum, the pedagogy, and the spatial arrangement of their seating positions”
(Nairn, 1997, p. 98) impact on how they behave and contribute in the classroom. Space can
have order and planning (Massey, 1992) and in school classrooms this makes sense if we
consider the curriculum planning and the classroom design which may be static. However,
space also has an element of chaos and unintended consequences both of which are observed
in the general social interactions operating in classrooms. I would argue that this chaos can be
used to disrupt the order of the curriculum, especially if a teacher is attuned to the changing
and evolving relationships within a classroom and uses these chaotic moments as chances to
develop thinking and discussion opportunities.
Schools are often viewed as places of “formal, abstract space” (Nespor, 1997, p. 121). Schools can turn students into “detached observers” (p. 122) by the process of regulation and control. School “defines regions of space and permissible forms of behaviour within these spaces” (p. 122) including what is allowed to happen in classrooms. Many teachers construct their subjectivities as teachers through how they manage and control their classroom and the students within their classroom. They frame their existence as teachers on the attributes and behaviours of their students often believing that by controlling such things as classroom noise they are defining their ability as a teacher. In this way teachers use the space of their own bodies and their classrooms to dominate the space of their students’ bodies.

The organisation of school space reinforces the notion of students being subordinate to teachers (Shilling, 1991) or the “regionalisation of classroom space represents the institutionalisation of adult control through spatial practice” (Nespor, 1997, p. 125). Space is used to regulate the bodies of students in such ways as; not allowing students to speak or discuss in class while working and, ensuring that students are restricted to the space allocated to them at a desk. Nespor (1997) suggests that “silence and motionless” (p. 128) are particular requirements in subjects such as mathematics because mathematics, like reading and writing, is considered one of the essential areas of learning at school. He writes that any problems about the organisation of classroom space are justified and dealt with solely from the perspective of the teacher. A key technique used by teachers to control the students in classrooms is the arrangement of the desks because this in turn controls the amount of talking which can occur. The arrangement of the furniture and the subsequent arrangement of the students around this furniture are strategic management techniques “designed to maximise the teacher’s ability to keep an eye on students and command their attention” (Nespor, 1997, p. 133).

In one study of a teacher and her class of students, it was shown that the metaphor “spaciousness” (Angier & Povey, 1999, p. 148) could be used to talk about the forming and framing of the “cultural space” (p. 148) of the mathematics classroom. This culture was “mediated by the texts used and the educational relationships lived out” (p. 148) in the development of mathematics’ classrooms. Students preferred to be involved in the creating of these cultural spaces. “Spacious educational relationships” (Angier & Povey, 1999, p. 151) offer a space where students can make errors and feel comfortable in finding and fixing these errors. The space also allows students to deviate from the task at hand and be socially involved with the other participants in the classroom.

The students in Angier and Povey’s study were adamant that the teacher, the placement in groups and how the class was organised were important aspects for their comfort in the
‘space’ of the mathematics classroom. One female student clearly expressed her opinion that part of feeling comfortable in her new mathematics class was about getting used to the ‘new space’ provided by the ‘new teacher’ and that this takes time and effort on the part of both the student and the teacher. The researchers found that the classroom culture was often a reflection of how the curriculum was being presented to the learners. Working from textbooks, learning mathematics in bite-size steps of repetitious examples resulted in the students themselves separating from their classmates to work as individuals. “When the content of the curriculum is atomised, there is pressure for social relationships within the classroom to become atomised too” (Angier & Povey, 1999, p. 154).

The students in this study preferred cooperative learning opportunities because they found these a positive way of learning, they liked the mutual support they experienced and they found that working with others allowed them to develop a better understanding of the mathematical concepts they were presented with. “Spacious mathematics is an open and creative subject” (Angier & Povey, 1999, p. 155) and this research showed how adjusting the ‘space’ in the classroom to create a different type of learning space opened up a new world of mathematics for these students irrespective of their gender and backgrounds. This has particular implications for girls who have been seen to negatively compare their ability to others and hence lose confidence in mathematics when they work in isolation. One female student in the study liked that she could freely think and express her ideas, valuing the “message that [her] contributions are essential to the class, that the mathematics is not wholly predetermined in a book or a lesson plan but it happens then and there” (Angier & Povey, 1999, p. 157).

These students respected how their teacher was able to transcend both the school space and the social space, that is, she was a participant in the classroom not just the person holding the power. The teacher was an integral component in the “spacious relationships” operating in the mathematics classroom, modelling real-life ups and downs associated with the learning process. They saw her as learning alongside them, making mistakes, remedying this, and negotiating with the students how they could best learn in the classroom.

The classroom needs to be a place where it is possible to model the process of looking honestly at things that are going wrong with a belief that there are strategies to redeem them. It needs to be a place in which both students and teachers can take risks and where it is possible for trust to be betrayed but given again or earned back. (Angier & Povey, 1999, p. 158)

Consideration of teaching environments/spaces and actively making changes to accommodate the varied needs of learners are important areas to be addressed (Boaler &
Sengupta-Irving, 2006), however, it is also important to explore how students’ subject choices are influenced by the spaces they come to be positioned and constructed in. This may involve not only looking at the way space is constructed around them, but also at how they occupy the spaces made available to them in schools (Mendick, Moreau & Epstein, 2009). Girls have been shown to opt out of mathematics because they perceive the classroom space as unappealing, arduous and intimidating to them (Gherasim, Butnaru & Mairean, 2013; Riegle-Crumb, Farkas & Muller, 2006). Friendly environments as well as the support and relationships with others, especially teachers (Averill, 2009), influence how spaces are experienced. The next section explores the literature related to the influence of others, particularly teachers and their pedagogical practices, on girls’ experiences of mathematics.

**Teachers as Significant Others in Mathematics**

Often in the past, discussions about girls in the context of mathematics education have failed to address the important role that others in their lives have on their construction as learners of mathematics (Campbell, 1995). This section reviews research related to one of the significant others in girls’ lives, that is, teachers and the influence they may have on girls’ mathematical conception of themselves, their experiences of mathematics, and how this may influence girls’ choosing to opt out of mathematics. Peers and parents are also seen as influential on girls’ experiences of school mathematics (Fox & Soller, 2001; Riegle-Crumb, Farkas & Muller, 2006; Shannon, 2004; Walshaw, 1999) however; this area is beyond the scope of this research study.

The book *Women becoming Mathematicians* (Murray, 2000) tells the herstories of thirty-six of the approximately two hundred women who gained PhDs in mathematics in America in the 1940s and 1950s. This post-World War II period was considered a time of expansion in mathematics and technology. Murray (2000) details these women’s experiences of mathematics during their schooling and the influences of their families and teachers. Most of the women had their first crucial encounter with mathematics under the guidance of a particularly inspiring teacher. Most lived at home during their college years, constrained by the availability of scholarships and the limited financial means of their families. They experienced biases at high school due to their abilities and curiosity and subsequently most viewed these limitations as challenges to overcome.

These women experienced resistance to continuing their mathematical studies as it was regarded as something unnecessary for them to do. Their teachers often did not take them seriously. For some of the women it took them a while to make the connection between doing
mathematics and making a living from doing mathematics. At that time many viewed attending high school as a serious undertaking, a mark of distinction, a privilege, and an important rite of passage into adulthood. These women appreciated high school as a place for sharing, testing and developing ideas in a social context. Home provided many of these women with a space that was intellectually stimulating and a place where books and ideas were valued and discussed. These women interviewees carved out a unique family niche within which their interest in mathematics began to grow and develop. This was mostly due to their emotional and material needs being met at the same time, as their intellectual interests were actively encouraged. Others came from more unfavourable circumstances in which their interests developed in spite of criticism. They used engagement with the mathematical world as a mechanism to enhance their own advancement and self-expression. The stories had many similarities and differences; however, it was evident that a diverse interplay of factors constructed them and their mathematical experiences.

Many of these stories still relate to girls today suggesting that although society has changed over the last fifty or sixty years many girls are positioned in mathematics education in the twenty-first century in similar ways so that the mathematical enjoyment, engagement and progress of girls is still inhibited. For many girls little has changed in mathematics as the sociocultural contexts girls are positioned in determine how they are subjectively positioned as learners of mathematics in spite of girls appearing to have access to the same level and quality of resources as boys (Burton, 2003). Research has shown that, in particular, lower achieving girls have made very few advances in mathematics over the last two decades (Goos, Stillman & Vale, 2007).

Ahlquist (2001) tells the disturbing story of the lack of sensitivity a white male mathematics teacher showed towards a successful girl in his class. He did not praise her high score on a difficult assessment, but instead chose to use her result as the focus of a haranguing of the boys in the class. Their sin was that a girl outclassed them. The girl learnt that girls should not do better than boys in mathematics. Unfortunately as a result of this “gross intimidation” this girls’ results dropped following this incident and she never repeated getting the highest score again (Ahlquist, 2001, p. 31). It is thought that teachers may unknowingly contribute to the construction of classroom discourses that exemplify differential gender practices in mathematics (Campbell, 1995). They hold the power to continue to act in the same way or to be made aware of their powerful role and try to eliminate practices that contribute to students being positioned as outside the realm of mathematical discourse. Often pedagogical practices and the familiarity and routine of classroom interactions, space, and teaching become the normal and it may seem difficult to think and act outside what one has
come to expect as the accepted way of things (St Pierre, 2000). The discursive context of mathematics classrooms positions girls in particular ways due to the practices they encounter in their classes (Mendick, 2006).

Teachers play a crucial role in influencing female students and more has been written about this than about the influence of parents and peers. Notions of teachers’ beliefs and knowledge are important influences on the development of gender differences in mathematics. Teachers, like all individuals, have their own set of personal beliefs, values and principles. These beliefs come from your parents, peers, media, church, the country you live in, what you read, and all other experiences of living. They are tacit and not easily identified, measured or studied (Fennema, 1990). The suggestion is that teachers have stronger beliefs about their students than the students do about themselves, and that they invariably perceive and evaluate both male and female students’ abilities as an ongoing part of their job as reflective professionals.

There is a great deal of evidence that suggests that teachers believe that certain subjects are more appropriate for males than for females. The stereotyping of mathematics as a masculine discipline can result in differential treatment of males and females in classrooms. Boys have been shown to have more attention and interactions with teachers in mathematics classes and to receive more praise from their teachers (Boaler & Sengupta-Irving, 2006). Stereotyping, through the use of boy-friendly styles of teaching, contexts, and classroom materials/resources, reflect many teachers’ opinion of mathematics being for boys (Boaler & Sengupta-Irving, 2006). Teachers often view male students as displaying higher levels of competitiveness, logic, adventurousness, loudness, volunteering of answers, enjoyment of mathematics, and independence in mathematics (Fennema, 1990). Early research tried to change girls into becoming more masculine or boy-like but now many researchers have suggested that the main issues with girls’ poor experiences in mathematics are related to the pedagogical practices and broader social issues rather than the concept of girls being inadequate or failures (Boaler & Sengupta-Irving, 2006; Mendick, 2006).

There appear to be some major issues, which if addressed by teachers could help to change gender beliefs in the mathematics classroom. Teachers and teaching environments have come under scrutiny and often the blame has shifted to teachers, however, this may be too simplistic (Boaler & Sengupta-Irving, 2006). Often teachers lack the knowledge of what are considered to be gender differences in mathematics especially in terms of the nature and quality of their interactions with students. What teachers know and believe about gender differences influences what each female or male should do (how they behave, work, and interact in the classroom) which influences what females and males learn in mathematics,
which influences gender differences in mathematics. Pedagogical interactions are closely linked to a teacher’s own background, experiences, and interest and commitment to mathematical learning (Walshaw, 2010). Most teachers aim to make their classrooms pleasant places for their students. In the case of female students this can be alleviating any stress, but by doing this teachers may fail to allow their female students to develop self-confidence and pride in their work. Learning opportunities for all may be opened up if we look outside of the mathematics itself and focus on how all students engage in the countless learning possibilities and collective collaborations that are presented and available in their mathematics classrooms (Davis & Williams, 2009). A good mathematics teacher has been shown as one that has an inspired teaching style, that is, they are skilled, competent and allow mathematical talk and open-ended shared learning experiences (Walls, 2010b). Another view is that good teachers are those who are caring as well as being able to explain mathematics well to their students (Anthony & Walshaw, 2010). Caring appears to be about whether the teacher had a relationship with the students based on knowing more about them than just their mathematical ability. The ability of teachers to provide varied pedagogical approaches and their personal goals for their students influence the attainment levels of the students they teach, and it has been shown that overall progress of students increases when they have highly skilled teachers in mathematics (Gherasim, Butnaru & Mairean, 2013). These good teachers need to equip students with a range of mathematical tools that they can carry with them post-school. Often many female students are not given sufficient independence and this results in lack of self-belief about their ability to succeed in mathematics due to their own ability (Goos, Stillman & Vale, 2007). They do not develop adequate self-esteem in mathematics and this results in negative emotions in mathematics and disaffection with the subject (Lewis, 2013; Nardi & Steward, 2003).

There is a false assumption that boys and girls receive equal education when in the same classrooms, with the same teachers using the same books. This is a false assumption when the research evidence shows that boys interact more with teachers and teachers interact more with boys (Boaler & Sengupta-Irving, 2006; Campbell, 1995); classroom activities are more often chosen to appeal to boys; boys receive more praise and discipline (more teacher-initiated contacts); teachers respond to boys’ requests for help (Sadker, 2000); and teachers criticise girls more frequently on the academic quality of their work. In some cases the quality of the interaction is of a superior form for boys as it includes beneficial feedback and encouragement (Fox & Soller, 2001). Research has shown that when teachers ask more abstract and probing questions then students learn to ask similar questions of the teachers and of each other. Positive encouragement of all students can result in a pedagogy of encouraging
and supportive practice where everyone in the class is motivated to assist and stimulate each other to learn and achieve (Boaler, 2008). Marzano and Marzano (2001) believe that the “quality of the student-teacher relationship is the keystone for all aspects of classroom management” (p. 6). Unfortunately, many mathematics classrooms are hierarchical environments where the teacher directs the learning and it is rare to find collaboration and negotiation as everyday experiences of mathematical classroom discourse (Boaler, 2008).

In general, a few male students can dominate a teacher’s attention (Jackson, Paechter & Renold, 2010). Teachers had many more interactions with boys in mathematics classes, and that these interactions were not predominantly for disciplinary incidents as many assume: “This differential treatment can contribute to faulty perceptions of ‘who does maths’ and to the identification of mathematics as masculine, feminine or neutral” (Campbell, 1995, p. 226). Recent research has shown that boys receive more support for their attention in their mathematical and scientific pursuits than girls (Gherasim, Butnaru & Mairean, 2013).

The quality and type of feedback to students in mathematics differs between boys and girls (Gherasim, Butnaru & Mairean, 2013). Positive feedback for boys in mathematics and science is more concerned with the intellectual quality of their work. This corrective feedback is more positive and encouraging than what many girls experience (Meece, Glienke & Burg, 2006). In contrast, feedback on the intellectual competence of the work was less negative. Males’ failures tended to be attributed to their effort and not their ability (Goos, Stillman & Vale, 2007; Watt et al., 2006). The opposite situation has been observed for girls. Teachers in this way reinforce that the failures of males/boys are perceived as due to lack of effort thereby implying that boys are able to control their own learning. In contrast, the failure of females/girls is perceived as due to lack of ability thereby implying girls have no control over changing this (Sadker, 2000; Skelton, Francis & Smulyan, 2006). Girls believe that they have to make a greater effort to continue to succeed and do not develop confidence in their ability and this creates in them a fear of failure, which they believe they cannot overcome.

Part of the gendered belief system of teachers relates to them as seeing mathematics as more useful for boys. More often than girls, boys are selected for both extension programmes, and more importantly for remedial assistance (Bianco et al., 2011). Teachers attribute the success and failure in mathematics of low-achieving boys more to their own teaching than the success and failure of low-achieving females. Fixing the inadequacies of boys in mathematics is seen as vital as it is perceived that boys need mathematics to secure a viable future however this has negatively impacted on the achievement and experiences of many girls (Francis, 2010a). Girls are left to struggle on in the larger classroom setting, their needs for extra assistance often overlooked. This is a subtle communication to girls that they do not need
mathematics. The negative stereotype of gifted girls is even more apparent (Fox & Soller, 2001). Some teachers communicate different expectations to gifted boys than they do to gifted girls and unwittingly reinforce that mathematics is an essential subject for boys, but unimportant for girls. This raises issues of equity where Fennema (1990) argues that equity means a legal right to equal access to mathematics, equal treatment in the mathematics class and equal educational outcomes. Equity can only be achieved when all learners have access to the mathematics they need.

The suggestion is that there needs to be change in the pedagogy in mathematics classrooms that part of this change needs to come from raising teacher awareness, as teachers are part of the causes of the gender practices that exist (Campbell, 1995). An “integral living pedagogy” (Renert & Davis, 2010, p. 198) could offer a way forward for mathematics educators. The suggestion is that if teachers were to be situated as “vital participants in the creation of mathematical possibilities” (Renert & Davis, 2010, p. 198) they could work with students to “co-create mathematics by elaborating, deconstructing and infusing mathematical concepts with new layers of meaning” (p. 185). This would mean a move away from traditional transmission-type pedagogies to more living contexts, novel constructions, and shared learning. The idea is that there is a shift from asking what is a correct answer in mathematics to asking what are the different ways we can talk about a mathematical situation.

There often appears to be a culture of non-negotiable “authoritative discourse” (Solomon, 2012, p. 175) in mathematics where the teacher too often holds the power in the mathematics classroom and the voices of the students become silenced. By being part of the cause this implies that teachers have the power to help to eliminate gendering practices. The discursive practices of treating boys and girls differently are not usually deliberate, but more often unconscious and unexamined (Fleming, 2000; Fox & Soller, 2007). If teachers realise that they are part of the problem then they could be shown strategies to alter their teaching styles. The desire to make changes can be linked to ideas surrounding “internally persuasive discourses” (Solomon, 2012, p. 173) where many teachers know they need to alter their pedagogy, but feel powerless to do so. Pedagogical practices within mathematics classes are seen as “complex and multilayered” (Lawrence, Anthony & Ding, 2009, p. 136) and, because of this complexity, inherent practices can seem “formidably difficult to change” (p. 136). This difficulty is a result of many teachers feeling consumed by the needs of their students to such an extent that they are unable to attend to their own learning needs to find the time to focus on professional reflection and enquiry.

Consent to experiment with new approaches may present opportunities for creative pedagogical approaches that may benefit and be more attractive to girls in mathematics.
classrooms. One thought is that if teachers use more cooperative strategies in their mathematics classrooms then girls may feel more comfortable offering and seeking assistance from their teachers and peers (Gherasim, Butnaru & Mairean, 2013). This approach may help to change motivational patterns amongst girls eliminating the focus on comparison between classmates and on their attainment levels. A refocus on mathematics as a subject concerned with reasoning rather than just memorisation could help to reposition pedagogies in the classroom (Maguire & Neill, 2006). Back in 1986, Shulman wrote that there were three forms of knowledge needed in order to be able to teach effectively (in Cotton, 2010). These were: the teacher having a deep knowledge of the subject itself and an understanding of the curriculum a teacher is expected to teach, and being able to draw on an “understanding of the range of pedagogical choices open to them that they may support learners in coming to an understanding of the context” (Cotton, 2010, p. 46). I would suggest that, unfortunately, even today all teachers in mathematics classrooms are not addressing these three forms of knowledge. Discussion within mathematics classrooms opens the door to more explaining, reasoning, and justification. Students can suggest a variety of responses and strategies and then negotiate with each other, and the teacher, to affirm new mathematical understanding (Maguire & Neill, 2006). I like Stinson and Powell’s (2010) suggestion that there should be a “horizontal relationship between persons ... [a] relation of ‘empathy’ between two ‘poles’ who are engaged in a joint search” (p. 45), teachers and students working together to co-create mathematical learning spaces in schools.

The most common practices reported by teachers teaching Year Eleven classes in New Zealand were tasks involving worksheets and textbooks, the setting of homework, and students discussing their work with other students sitting in close proximity to them (Harvey & Averill, 2008). Experiences related to being put on the spot to answer questions in class, copying notes, working quietly from worksheets and textbooks and, working independently of others are pedagogical practices that many girls experience in mathematics. These ways of learning mathematics in traditionally taught classrooms help to sustain their views of mathematics as being about “conflict and struggle” (Boylan & Povey, 2009, p. 76); conflict and struggle associated with dislike, boredom, irrelevance and disinterest.

Little will change for girls in mathematics unless there is a change in the way teachers stereotype readings of success and failure and how these impinge on classroom practice where students are labelled as good or bad according to how they behave and interact in the classroom environment (Boaler, 1997a, 2002, 2009; Leder, 1990b; Mendick, 2006; Willis, 1989). Girls have to deal with conflicting demands of femininity and masculine forms of intellectuality (Mendick, 2006). These problems are complex and there are no simple
solutions. Some would suggest that the responsibility for change lies with teachers and that they need to deconstruct the myths apparent in mathematics education so that girls empower themselves.

The attainment of girl-friendly classrooms could be achieved with a reduction in gender differences in the mathematics curriculum and teaching process, less social comparison and competition, and a warmer and fairer classroom atmosphere (Bryant, 2011; Campbell, 1995; Spielman, 2008). “Activities that stress competition over cooperation tend to favour boys over girls in the learning of mathematics” (Campbell, 1995, p. 236). These types of activities could include such things from the well-used timed basic facts tests through to competitions run by outside agencies including the Mathematics Olympiad and the Australian Mathematics competition. Another area that stresses competition over collaboration is the use of test-like internal and external assessments in mathematics (see Black, Mendick & Rodd, 2009; Smith, 2010).

Campbell (1995) suggests that gender-neutral activities which may encourage girls in mathematics classroom could include: interaction with all students irrespective of their gender (a characteristic of an equitable mathematics class); maintaining order; stressing the importance and value of mathematics; positive encouraging of all students; and removal of all sexist language, humour or materials. Another strategy could be inviting visitors from mathematics-related fields who are not stereotypically nerdy. Campbell (1995) advocates that girls may consider mathematics-related careers as a result of meeting and working with more scientists and engineers but if the foreseen barriers to learning and working in mathematical fields are stressed without reference to adequate solutions then girls will still opt out. Suggestions for overcoming barriers and dealing with stereotypes may encourage girls to look favourably on mathematics or science careers. Fox and Soller (2001) argue that experiences with women in mathematically related employment need to occur over extended periods of time. They also propose that interventions of this sort need more rigorous evaluation.

The influence of teachers on girls in mathematics is well documented. Teachers’ actions in their classrooms have “twice the impact on student achievement as do school policies regarding curriculum, assessment, staff collegiality, and community involvement” (Marzano & Marzano, 2001, p. 6). An important role of any teacher is to provide a well-managed classroom free of chaos, a varied pedagogy, flexible learning goals, and a personal interest in every student regardless of gender. Stereotypical views of girls in mathematics still exist, but are more subtle than they used to be (Shaw, 2009). The issues appear to be more concerned with providing an environment conducive to girls in mathematics, and ongoing recognition that mathematics is for girls as well as boys. The next section examines ideas about how girls
feel about school mathematics by looking at research related to affect and emotion in mathematics education.

**Affect and Emotion in Mathematics**

Any discussion on girls’ experiences of mathematics evokes feelings and emotions (Boylan and Povey, 2009; Shaw, 2009; Smith, 2010; Walshaw & Brown, 2012). At my first ever conference presentation in Townsville in 2004 I was overwhelmed by the emotion that was brought out through the discussion of Jane’s story (Shannon, 2004). So many participants at my presentation wanted to tell me their story about how mathematics was and how it felt for them. The same is still true whenever I talk to people about this thesis everyone (particularly girls/women) has a story to tell and they want to tell it. I could have filled notebooks full of anecdotal evidence to compliment the stories of the research girls in this thesis. This continual dialogue in public spheres reassures me that my girls’ stories are important and need to be told and critically examined. Not all of the stories I am continually told are negative, they are wide-ranging and tied to multiple ideas about how mathematics was taught, how they felt in mathematics, favourite mathematics teachers, worst teacher experiences, and so on.

Recent New Zealand research by Ingram (2011) looked at the affective domain in mathematics in New Zealand and in particular, students’ complex and dynamic relationships with mathematics. The components of these relationships were the students’ views of mathematics, their mathematical knowledge, and their feelings, identities and habits of engagement. Our research timeframes overlapped and many discussions were had (and continue) about the intertwining and overlapping of our two sets of data. Although my focus is a particular interest in girls’ experiences of mathematics and their other school subjects from a poststructuralist perspective, the stories from Ingram’s study show many consistencies and alliances with the experiences articulated by the girls. Later, during my findings chapters this will be examined in more detail.

Therefore, although this thesis is not specifically about affect in mathematics, my findings demonstrate that affect could not be removed from their experiences. In this section I will briefly outline some relevant literature with respect to how students feel about mathematics and how these feelings impact on their engagement with school mathematics, their enjoyment of mathematics, and the choices they make about whether to continue or not with the study of mathematics. Issues of self-esteem, anxiety, and emotion are involved in
how students are positioned in school mathematics and how their mathematical subjectivities are constructed (Lewis, 2013).

The field of *affect* encompasses the concepts of beliefs, attitudes and emotion (Black, Mendick & Rodd, 2009; McLeod, 1992). The learning of mathematics generates a range of affective responses both positive and negative. McLeod (1992) sees these as ranging from: emotions as the most intense/least stable, attitudes situated in the middle and beliefs as the most stable/least intense. Positive responses are generally related to success in being able to do a mathematical problem or pleasure at getting a *right* answer. Unfortunately, many responses are negative related to feelings of anxiety, frustration, despair, and lack of enjoyment of the subject (Evans, 2000). McLeod (1992, 1994) insists that as students move through school this negativity intensifies and plays a critical role in decisions to opt out of school mathematics in the final years of schooling. Zan, Brown, Evans and Hannula (2006) suggest that constructs such as “motivation, mood and interest” (p. 117) are also used in conceptualising affect. They are interested in how affect and cognition are related and suggest that “discursive approaches emphasise the social *practices* within which activity takes place, and the way that *positions* made available by these practices enable and constrain both thinking and the emotions experienced” (p. 117). Zan et al. (2006) are most interested in which dimensions of affect are significant to mathematics education and how affect is involved in mathematical thinking and behaviour.

Roeskin et al. (2011) studied the cognitive, emotional and motivational aspects of student’s experiences with mathematics in Finnish secondary schools. They use *view* to replace *beliefs* seeing *view* as a more holistic approach. Beliefs are seen as a “messy construct” (p. 498), hard to define and more about personal understandings than those of the social collective. From their data, Roeskin et al. found that students, when discussing ability, believe that to be good at mathematics requires special talents that they are born with. They found that “students with positive views believe themselves to be talented in mathematics, to do well in the future, experience mathematics as easy and also like doing mathematics” (p. 505). The opposite of this then, having negative views, influences how students experience mathematics creating barriers for engagement with the subject at school.

As mentioned earlier, girls’ views of mathematics are influenced by many factors. However, mathematical achievement does not always result in positive views of mathematics as identified in Jane’s story (Shannon, 2004) where Jane was a high-mathematical achiever but *hated* mathematics. Georgiou, Stavrinides and Kalavana (2007) found that the only gender differences in mathematics achievement and attitudes came down to differences in the ways boys and girls explained their performance in mathematics. Girls “refuse to emphasise their
abilities, whereas boys do not miss the chance to do so” (p. 338) reflecting stereotypes of girls positioned as not being able to do mathematics. Unfortunately, underestimation of ability and self-doubt link to ideas about emotion and there is a prevailing discourse that emotion has no place in the study of mathematics (Hannula et al., 2004). This reinforces the notion of mathematics as a rational subject, a “purely intellectual endeavour” (p. 109) which emphasises the binary construction of mathematics as for males, free of feeling and sentiment, values associated with the feminine.

I have found most of the research on affect in mathematics somewhat limiting when examining how girls/women as a group feel about mathematics (Boaler & Sengupta-Irving, 2006). The studies tend to be quantitative based on students filling in predetermined questionnaires or positioning their responses on scales, that is, self-reported data rather than observational data. There has been some work in New Zealand on primary students’ beliefs about mathematics and in Australasia on teachers’ beliefs. Studies have also focused on aspects of identity particularly with respect to pre-service teachers whereas I have chosen to look at subjectivity through the lens of feminist Poststructuralism (see Chapter Two). There is a view that more research needs to be done on affect using mixed method studies with multiple data sources. A focus on classroom-based research on students using observational methods and more action-research would add to this field of study. There are also gaps on community and parental beliefs about mathematics. (For further discussion on Australasian affect research, see Grootenboer et al., 2008.)

Ingram (2011) has addressed some of these deficiencies in the affect literature by examining how her high school research students feel about school mathematics in Year Nine through to Year Eleven using personal journey graphs alongside interviews, observations, and drawings to detail her students’ passage through school mathematics. She has not examined affect specifically by gender, although some of her analysis reports on case studies of specific girls. Affect literature focusing purely on girls is rare, and if present it is lacking in detail about self-concept, motivation, and engagement, being more focused on beliefs. I see the emotion, feelings, and personal views of girls’ as important aspects of how girls are constructed in the discourse of their everyday experiences of school mathematics. My girls’ stories will provide suggestions for what is experienced as wrong in mathematics and how possibly their other school subjects allow for a more positive experience than that which occurs in mathematics’ classrooms. Connected to this issue for many girls is whether school mathematics is a useful subject for them now and in their futures.

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4 Identity is not a focus of this thesis. Many researchers have looked at identity construction in mathematics education. For more reading on identity see Gee (2000-01), Ingram (2011), Nasir (2002), and Sfard & Prusack (2005a, 2005b).
The ‘Utility’ of Mathematics for Girls

Some researchers (Boylan & Povey, 2009; Mendick, Moreau & Epstein, 2009; Smith, 2010, 2012) focus on girls having the capacity to choose or not choose mathematics, however, others express the idea that choosing mathematics at school is closely tied to girls’ views about the usefulness of mathematics to them personally and in their futures (Christiansen, 2007; Sfard, 2009). Measures of “maths-relatedness of adolescents’ career intentions” (Watt, 2006, p. 308) suggest that there is a real social importance of such work. Boys, more than girls, plan to study mathematics at higher levels and they keep to this plan; whereas girls perceive mathematics as a difficult subject and so do not make similar plans (Watt, 2006). This perception of difficulty affects girls’ own self-perceptions of how able they are in mathematics and leads to future lower participation in mathematical courses. Girls who rate mathematics as highly useful are the only girls who showed leanings towards continuing to maths-related careers in the future. In contrast to this, boys look at potential maths-related careers even when they rate mathematics as only moderately useful (Lundin, 2012).

The usefulness of mathematics is called its “utility value” (Watt, 2006) and of concern is data that showed that girls’ maths-related self-perceptions exhibited dramatic decreases during their time at school. This filtering process, through perceptions of the hardness of mathematics, can begin as early as the first year of secondary schooling and these early experiences and subsequent follow-on decisions in respect to school mathematics have long-lasting effects for all students (Shapka, Domene & Keating, 2006). Filter effects of mathematics may even begin before students enter high school suggesting that more research is needed on reasons for disengagement, especially in regards to the retention of girls who are the most at risk of disengagement from mathematics (Shapka, Domene & Keating, 2006). These examples beg the question, “What is happening to girls in mathematics while they are at school?” and require further investigation.

That there is a “maths pipeline” (Watt, 2006, p. 319) and that girls opt out of this pipeline as soon as mathematics is perceived as getting harder is a great concern. Anecdotal evidence from my own experience of tutoring girls in an after-school tuition centre over the last few years supports this here in New Zealand. During Year Twelve many girls abandon either one or both of the Calculus and Algebra papers and with this move restrict themselves to only one choice of mathematics course in Year Thirteen, if indeed, they even choose to continue with mathematics at all.
Research in a German high school shows how course selection is a gendered process influenced by factors such as: the cultural norms that surround issues of gender, parenting influences, and students’ own self-concepts and values (Nagy, Trautwein, Baumert, Koller, & Garrett, 2006). These factors influence course selection, which then influence future fields of chosen study, which go on to determine future occupations. Academic self-concepts and achievement are closely connected with results that showed mathematics and verbal achievement as highly correlated, and mathematics and verbal self-concepts as only weakly correlated, a pattern that they call “paradoxical” (Nagy et al., 2006, p. 325). This is termed a “social comparison process” (p. 325) where students are comparing their own achievement with their perceived achievement of their fellow students, or more specifically in terms of mathematics, they think of themselves as either a “‘maths’ person or a ‘verbal’ person but not both” (p. 325). It was shown that boys aged 16-17 who have a high mathematics self-concept are more than twice as likely to choose an advanced mathematics course than those female students with lower mathematics self-concept (Nagy et al., 2006). The data also showed how girls who were not comfortable in mathematics and chemistry/physics were more attracted to studying biology courses at high school, data that also has links to the experiences and choices of my research girls and will be discussed later.

Poststructuralist Theory in Mathematics Education

Over recent times many researchers in the field of mathematics education have engaged with frameworks within the postmodern and poststructuralist arena. The amount of published material in this area has grown significantly and as such I wish to examine how a sample of colleagues have engaged with mathematics education through the lens of feminist poststructuralism.

This first section looks at postmodern ideas which are closely linked to my use of poststructuralist frameworks, at times these two terms postmodernism and poststructuralism are used interchangeably as related to the particular researcher’s emphasis. Postmodern practices have allowed for alternative ways of thinking about mathematics education (see Walshaw, 2004) and below I will examine some of the key ideas that link to my research. Walshaw’s edited book focuses on postmodernist ideas and I have chosen to examine some authors’ work that clearly resonates with my research data. Walshaw believes when researchers use postmodern frameworks we do not need to completely throw out conventional theoretical ideas but look more for a “shift in attitude” (p. 11) and a closer examination of our own personal stance in the research process. Postmodern ideas in mathematics education are
important for moving discussions to unmapped territories and for interrogating present practices so that new questions can be posed. Postmodernist researchers want “ongoing engagement” (Walshaw, 2004, p. 11) to produce new knowledges and new ways of thinking.

Ernest (2004) has looked at the absolutist nature of mathematical knowledge and how postmodern ideas linked with social constructivist perspectives allow for the problematizing and reconceptualising of the knowledge produced in mathematics classrooms. He investigated mathematics as conversation and suggested that if we think of mathematics as texts constructed in “social/institutional settings” (p. 31) and linked to contexts, that it can be interpreted in different ways and not just in terms of traditional ideas where mathematics is seen as about rules, patterns, and unchanging modes of transmission.

Valero (2004) critically examines mathematics by looking at the dominant discourses surrounding how the learner of mathematics is constructed. She believes that we need to break from “deeply entrenched modern systems of reason” (p. 51) and critique how mathematics works in society to produce a particular type of student. She also believes that we need to examine how researchers themselves may continue to reproduce a particular view of mathematics and show alternative postmodern ways of examining practices and looking at how change can be realised.

Two of the key ideas linked to poststructuralist theory: agency and power have been examined in mathematics education (Macmillan, 2004; Meaney, 2004). Macmillan showed in her work, with emergent mathematics learners in beginning school settings, that when children are immersed in the language of a new concept they are able to execute certain types of agency to construct their own mathematical-world. Where teachers encourage talking and listening in a supportive and encouraging environment young mathematical learners were able to take up mathematical ideas easily and show confidence in their understanding of mathematical learning. This construction of a comfortable learning environment can be seen as a successful method for students to have agency in the learning of mathematics and has implications for how mathematics could and should be taught to older learners.

Meaney’s (2004) work in a multi-cultural mathematics setting brought to the fore issues surrounding who holds the power in research settings and in fact in any mathematics classroom. Power is portrayed “as ebbing and flowing between community members and [oneself] as different knowledge [is] offered, produced, modified and accepted” (p. 196) and although Meaney was particularly interested in her own powerful relationships with the research community she was working in, her ideas about how “power is inherent within all interactions” (p. 197) has useful implications for all relationships in the learning of mathematics. Continual reflection on research processes and classroom interactions are
paramount in the examining of how girls are positioned in mathematics at secondary school through the relations of power of all who influence mathematics in schools. Meaney calls these “differentials in status” (p. 198) and how these exist between all participants in mathematics need consideration.

Klein (2004, 2009) has worked with many pre-service mathematics teachers and has examined their experiences using a poststructuralist lens. How these trainee mathematics teachers view mathematics has many strong links to how the girls in my research group also viewed mathematics. How teachers, prospective teachers, and students are subjectified in mathematics and the inherent issues of power in mathematics learning contexts and environments are some key ideas in Klein’s work. They are “subjected to power relations of inclusion and exclusion that constitute an unconscious knowledge of and about mathematics, of who can and should do it, and how it can be taught and learned” (Klein, 2009, p. 677). Personal experiences of school mathematics flow through to become “constituted knowledge” (p. 677) of what mathematics is really about. When teachers (read this as pre-service teachers as well) have experiences of school mathematics that impacted on how they feel about mathematics later in life they have two possible choices for how they then become teachers of mathematics. They can aim to become a different type of teacher themselves or they can become positioned as a mathematics teacher just the same as the teachers who taught them.

As pre-service teachers go through their training Klein found that they took on-board all the new ways of thinking that are taught at the tertiary establishment. They begin their journey as mathematics teachers believing that they can make changes and as such make a difference to how their own students experience school mathematics. They have:

Simultaneous positioning ... as having a real presence in the discourse, as author or initiator of sense making streams and as one who can and should go beyond the given to forge new ways-of-being. (Klein, 2009, p. 678)

Klein says that in poststructuralist thought this sense of presence is concerned with these individuals’ positioning in regards to how one values and respects the contribution of those who are teaching them about the teaching of mathematics. However, the mathematics environment, like all environments, is considered to be coercive because there are always power relations in play. This is not always a negative thing (the word coerce tends to conjure up negative thoughts) as participants can be coerced into ways-of-being in mathematical discourses which may indeed be enabling and empowering. Klein suggests that teachers actually find “comfortable spaces within the discursive parameters that constitute professional practice; each day they operate within these parameters” (p. 680). I suggest that the same is
true for girls in mathematics in that they learn through social positioning to become a learner in mathematics in a comfortable space they self-create by enacting through the discourses made available to them.

Klein’s teachers actively move their teaching style to encompass more “active participation” of their students in their classes instead of the “transmission-like coverage of content” (Klein, 2004, p. 36) that reflects their own experiences of school mathematics. As mentioned previously, girls in particular can benefit from being more actively involved in the learning of mathematics through cooperative and collaborative, and investigative learning experiences (see Boaler, 2009). Klein uses poststructuralist theory to examine “visible, previously unseen aspects of pedagogic practice” (p. 36), not to prove anything. Klein’s research presents more evidence of the binaries of mathematics, this time from the perspective of the pre-service teachers who in many ways are still learners of mathematics themselves. As I read Klein’s research paper (Klein, 2004) I was able to draw up a set of binaries operating for these teachers with many similarities to how girls experience mathematics within classrooms. This was not the intent of Klein’s work but links well to my research:

- Knowing mathematics/ not knowing mathematics
- Applying mathematical ideas/ not able to apply ideas
- Respected or competent learner or participant in maths education/ not respected or competent
- Traditional instructional patterns/ inquiry-based learning
- Giving correct answers/ explaining a problem

These teachers have a “lingering legacy” (p. 38) of their own experiences of mathematics from both their schooling and training. They often revert back to the old ways (most of the left-hand side of the binaries above) even when they know better. This is often driven by the desire to please their associate teachers, when on practicum, or later pressure to get the work done in a way that prepares students for examinations (Hagan, 2005). Even when teachers have strong memories of features about school mathematics they disliked such as: rote learning tables, procedural mathematics such as long division, and the need for ‘right’ answers given quickly under pressure, they may still slide into using these same methods. I wonder if part of this is that teachers perceive themselves to be judged so much on the performance of their students in assessments rather than on what they actually know and have learnt.

School mathematics can often be more about learning what you cannot do than what you can do. For girls this is a particular problem because they are made to feel that they
cannot learn or do mathematics within the realm of their experience. Largely, Klein (2004) found that often doing well/not doing well is perceived as a result of “personal circumstances, choice or ability” (p. 40) which suggests that girls are made to feel that is their problem and that all they need to do is change their attitude. This sits with the notion of the “absolute authority” (p. 40) of the teacher, resources, and the assessment tasks, that is, these things decide who can or cannot do mathematics. Klein suggests that this may “dim the flame of self-authored investigation and inquiry” (p. 40) by implicating this type of learning as not real learning reinforcing the belief that only the teacher or assessment can tell you about what you know or do not know.

Moreover, even when students are allowed to freely engage with a problem they sometimes feel they cannot go off on a tangent because they believe that their teachers still want them to get to a right answer. Often students are told there are many possible ways of doing a problem but they later find that the marking schedule reflects only limited methods so teachers indeed still expect this right way of doing the problem. Final grades may reflect having answered a question in the prescribed right way rather than a student’s actual knowledge and understanding of the problem at hand. Mathematics teaching often reverts back to a “linear” (p. 42) mode where the “focus on the correct answer constricts or narrows the potential learning experience” (Klein, 2004, p. 41). This causes me to ponder whether mathematics is just too fixated on results and if this is the case in all school subjects?

Klein (2004) sees mathematical spaces as “unenviable” (p. 43) spaces since “truths” about teacher education, current classroom teachers, teaching practice, and prescribed mathematics education discourses are so difficult to change. Mathematics teachers are still seen as the “fount of all knowledge” (p. 44) and this has many implications for pre-service teachers and students in mathematics. My suggestion is that when we train teachers of mathematics we need to choose associate teachers very carefully, those who model good mathematical practice that empowers students and those who are likewise open to new ideas. How this can be done is problematic. Who decides what a good mathematics teacher is? The good mathematics teacher may not be the teacher with the best assessment results; they may be the teacher who has engaged their students to learn a lot of mathematics. This might not necessarily show in their results, actually this may be too difficult to even determine while they are at school as the students themselves may believe that a good mathematics teacher is one who gets them through their examinations successfully!

Klein (2004) discusses the model of “border pedagogy” (p. 42), a concept addressed in more detail in the work of Henry Giroux (see Giroux, 1988, 1991; Giroux & McLaren, 1994). This fits well with poststructuralist theories as it introduces the idea of allowing multiple
interpretations and new storylines for how mathematics should be taught but also identifies that a *space* needs to be created for this to happen. This space must empower teachers to act for change. Romo and Chavez (2006) note that border pedagogy teaches skills associated with critical thinking so that meanings of power can be debated openly and subjectivities addressed. It also encourages consideration of tolerance and openness to new ideas so that new experiences can be constructed and through “sociocultural negotiation” (p. 143) students can position themselves differently and construct new meanings. In the following section, ideas surrounding space are examined in more detail with special consideration of how constructions of space work in educational settings.

**Conclusion**

In this chapter I have examined some of the literature related to girls and mathematics. A recurring theme is girls’ dislike for mathematics and considerable research has been undertaken to examine this. I have found that there are some gaps in the literature related to:

- the peer influence on girls’ choice to study mathematics,
- studies on affect that are qualitative and relate directly to girls,
- examination of the *space* provided in mathematics classrooms for girls and how this differs from other school subjects,
- and research on the specifics of why girls like their other school subjects more than mathematics.

I hope that my research findings will go some way to addressing these gaps as I examine the experiences of my research girls in both mathematics and their other school subjects.
CHAPTER FOUR: THE RESEARCH DESIGN

The purpose of this chapter is to describe the methodology of this study into girls’ experiences of school mathematics and their other school subjects. As a result of previous work (Shannon, 2004), the following questions were posed and investigated:

• What are girls’ experiences of secondary school mathematics?
• How do girls’ experiences of mathematics compare and/or contrast with their experiences of their other secondary school subjects?

In this chapter, the development of the research design is explained and the specific methods I employed are detailed. This study was not a longitudinal study; it was a period of intensive engagement with the school lives of a group of girls. The details of the choice of participants are justified along with ethical considerations, and reflection about how to allow the voices of the girls to be heard together with my own voice and what I bring to the research process. As detailed in Chapter Two, the research methods are underpinned by poststructuralist theory.

The Pilot Study

During the initial stages of my doctoral studies I was working part-time at an urban, decile 10, Integrated school (decile ratings range from 1 to 10. Schools with decile rating 10 reflect the highest socioeconomic sections of New Zealand society). Integrated schools are deemed to have special character related to religious or philosophical beliefs. This school has a maximum roll of 565 students. The school is coeducational from Year One to Year Six (primary) and girls-only from Year Seven to Year Thirteen (secondary).

I had some ideas about the type of research I wanted to do but I was not sure about the finer points of detail. I wanted to do my research in a coeducational school and I wanted to undertake the following:

• Observations of girls in their mathematics classrooms
• Observations of girls in their arts subjects
• Interviews with the girls
• Interviews with their mathematics teachers

The suggestion was made that I should do a pilot study. Pilot studies are small-scale versions of the main study usually undertaken to trial particular research methods and identify
any potential practical issues in advance of, and in preparation for, the main study (Teijlingen & Hundley, 2001). Undertaking the pilot study in the school I was working in was convenient for time management and ease of access. However, as with any research with youth I was required to gain ethical approval prior to the pilot study so although the pilot was a trial, considerations of methods had to be documented clearly. Ethics approval was given by the university to follow one student around her classes where she would wear a small microphone attached to a small audio recording device. I was to sit near to the rear of each class and have a recording device adjacent to myself as well. At the conclusion of a series of classroom visits I was to undertake a semi-structured interview with the student at a time convenient to her.

I had no particular preference which student would take part in the pilot study so I asked the Head of the Mathematics department to suggest a suitable candidate. My only request was that the student would have a subject course that included subjects considered to be girls' subjects as well as mathematics. As the Head of Mathematics was also the school timetabler she was in a position to select a student who fitted my requests and who was also a student in her own mathematics class. This particular teacher was very enthusiastic about being involved in my research.

Another consideration was which year group to select a student from. As it is difficult to do longitudinal studies in the timeframe allowed for doctoral research, consideration was given to the year grouping to work with. I felt that Year Twelve was a critical year for students as they are beginning to think ahead to future careers. It is also the first year in most New Zealand schools when mathematics is no longer a compulsory subject. I also hoped that Year Twelve students would be more prepared to share their experiences with me then trying to work with a younger cohort.

Lucy (all names are pseudonyms) was the student who took part in the pilot study. The pilot was undertaken to trial the methods for collecting data for the main study but I gained permission from Lucy, her parents, the school Principal, and her teachers to not only conduct the research trial in their classrooms but to be able to use any data that came out of the pilot study. In hindsight this was a good decision as although Lucy was a student in a single-sex school (my main study was to be done in a coeducational school setting) some very interesting data came out of the pilot, which was to impact greatly on the final research design and the focus of the interviews. I undertook classroom observations in three of Lucy's classes: mathematics, geography, and design. I wanted to observe her in English classes as well, however her normal English teacher was on leave during this time and it was decided it would be inappropriate to do observations in a class being taken by a relief teacher.
A huge realisation for me was how the physical environment of each of the classrooms also influenced the classroom experience for Lucy. I wrote detailed field notes during the observations and as part of these I drew birds-eye plans of the classrooms in my notes. I recorded where the students sat and how the desks, whiteboards, windows, and more were placed in the classrooms. This was not a planned move, but this noting down of the placement of people and furniture in the classroom allowed me to reflect on the different space in each of Lucy's classes and the physical numbers of students in each class related to that space.

As a result of my observations I developed an overwhelming concern about inequities faced by the students in Lucy’s mathematics class compared to Lucy's other classes. This was solely based on how little room the girls had to work in within the densely populated mathematics classroom and the impact this had on the amount of time the teacher was able to have with individual students because of the crowding. The question raised from this was "How much is mathematics pedagogy driven by the sheer numbers of students in the mathematics classrooms?" I wanted to capture a view of each of the three classrooms and felt that although my written plans would help my retention of information about the classrooms that I needed another way of documenting the physical details of the classrooms.

I decided to digitally photograph the classrooms so as to provide myself with ‘memory joggers’ of what it was like in the rooms. I felt this would enhance my memory of the observation process and supplement the audio recordings and field notes. I asked each teacher's permission to take photos of their rooms without students in them. The geography and mathematics teacher agreed unquestioningly but interestingly the design teacher questioned my motives. She asked me why and when I explained that I wanted some evidence of the differences in the sizes of the rooms so I could look at some issues including such things as the number of students per room she responded with the statement, "But you don't need to get out of your seat in maths". This statement was to have a huge impact on the whole direction of my research journey from that point as I began to consider the impact of subject spaces on the experiences of girls in mathematics and their other school subjects.

The Main Study

Following the pilot study I felt reassured that my original research questions were still relevant and I was satisfied that the data collection techniques had been trialed successfully. There are often concerns about the use of pilot data alongside data from main studies; however, “contamination is less of a concern in qualitative research” (Teijlingen & Hundley, 2001, p. 3) and pilot data is useful for showing the progression of the research process as well
as for gaining useful insights that can be used to improve future management of the research process. Pilot studies also suggest the likely outcomes of the research, as was the case of my pilot study of Lucy.

The only aspect of the pilot that still caused some concern was the effect on normal classroom behaviour caused by the wearing of a microphone. According to her teachers, and in particular her mathematics teacher, Lucy was usually a fairly talkative student in class and at times was more prone to off-task behaviour than total focus on the tasks set in class. During my observations of Lucy she was very quiet in each of the classes and there was limited conversation captured on the audiotape that she carried in class. I felt that with each lesson she was less inhibited by the wearing of the microphone and taping device as shown by her becoming slightly more animated each lesson. Because of this I felt comfortable that in the main study the issue of the research subjects wearing microphones could be one of patience, that is, at first I might not get a lot of personal data recorded in class but over time this might improve.

My next step in the research journey was to contact the Head of Mathematics at a local coeducational state secondary school. I chose this school for the following reasons: I had never taught in the school, I knew the Head of Mathematics because we had completed our teacher training together, and the school had the characteristics I was most interested in, that is, coeducational, vicinity for ease of access, average decile rating, and a state funded school. The school is an urban, coeducational high school. Students start in Year Nine and generally stay until Year Thirteen. The decile rating of the school is 7. The school roll is approximately 600 students.

I gained ethics approval from the university for the main study and the Principal of the school agreed to me doing my research in the school. I also organised to interview the Principal before I started the research. This was not in my initial plan, but when I met with her to discuss my research proposal some interesting comments made me curious about her opinions on girls and mathematics. This Principal is female, she was appointed to the position in 1998. It is quite rare for a female to be the leader in a state, coeducational school in Aotearoa/New Zealand and her comment in our initial discussion that “I didn’t need much maths to get to where I am, it didn’t stop me” made me anxious about the flow down effects of such an attitude to mathematics and female students.

I met with the Head of the Mathematics department (HOD) and explained the research I wanted to undertake. I gave him the information and permission forms and he offered to organise the group of girls for me. We decided to research a group of approximately twelve girls in Year Twelve mathematics classrooms. My only request was that I did not particularly
want overseas students or Year Eleven students who had been accelerated. This request actually made life difficult for the HOD. When I met with him a couple of weeks later he was most apologetic because he had only found me eleven girls to work with. He went on to explain that these eleven girls were the only girls, apart from those in the above categories, who were actually studying Year Twelve mathematics in the school. This was eleven girls out of a total of seventy-five Year Twelve students studying the Level Two NCEA mathematics course. I was later to discover that there were some other girls, but they were studying the lower-level mathematics courses available at Year Twelve. One girl joined my research group from the lower-level class during the research time and another who was not studying any mathematics. I will discuss this in more detail later in the chapter.

The HOD did a lot of groundwork for me in the school before I commenced my research. He spoke to the whole staff in a meeting about my research and informed them that I would be following these girls around their subjects and that I would be interviewing them soon after the observations. He provided me with the girls’ subject choices and subject lines (these are a list of which subjects are taught in each part of the school timetable) and a copy of the school timetable so that I could preplan my timetable for observations to cover as many different curriculum areas over the two terms I was there. This preliminary work certainly made my life easier because when I commenced the observation phase the teachers in the school were expecting me and appeared to be very accepting of my presence in their classrooms. I also made every attempt to be in the staffroom for interval and lunch breaks so that they had the opportunity to talk to me about my research if they wished. Many of them did and these conversations provided me with lots of further insights into the research girls and the culture of the school.

The Girls

The main study began with a group of eleven Year Twelve girls. Year Twelve was decided on as the most suitable group to research and the reasons for this follow. Year Twelve is the first year of schooling in Aotearoa/New Zealand when mathematics is not a compulsory school subject so it follows that students have made a choice to study mathematics at this stage of their schooling. Year Twelve was also chosen as it was anticipated that by this stage of their schooling the students would be better able to articulate their thoughts about their educational experiences and that they would also have started to consider their future career paths and be able to relate this to their school subject selections and their perceived usefulness of mathematics in their decisions.
These girls all studied a full NCEA achievement standard mathematics course. The girls are what I have termed ‘average’ girls. Many researchers draw on extreme examples for their research (Mendick, 2005) so that often the *average* girl can seem to be overlooked. They were not girls who would generally be considered for case studies because they are not as fine, Weis, Weseen & Wong (2000) suggest the “exotic or bizarre” (p. 118). They did not stand out in class as being behavioural problems or as being the hardest workers. In my opinion, they were a group of girls similar to many groups of girls that you might find in any mathematics classroom in any coeducational school in Aotearoa/New Zealand. They were selected because they studied mathematics alongside feminine subjects.

Table 1: Full course list for each of the girls (pseudonyms are used).

<table>
<thead>
<tr>
<th>Name</th>
<th>English</th>
<th>Mathematics</th>
<th>Art</th>
<th>History of Art</th>
<th>Biology</th>
<th>Maori</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vicki</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Art</td>
<td>History of Art</td>
<td>Biology</td>
<td>Maori</td>
</tr>
<tr>
<td><em>Ngaire</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Music</td>
<td>Biology</td>
<td>Physics</td>
<td>Chemistry</td>
</tr>
<tr>
<td><em>Harriet</em></td>
<td>English</td>
<td>Mathematics</td>
<td>History</td>
<td>Chemistry</td>
<td>Drama</td>
<td>German</td>
</tr>
<tr>
<td><em>Tara</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Business Studies</td>
<td>History</td>
<td>Drama</td>
<td>Economics</td>
</tr>
<tr>
<td><em>Joy</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Physics</td>
<td>Computer Studies</td>
<td>Text and Information Management</td>
<td>Fabric Technology</td>
</tr>
<tr>
<td><em>Polly</em></td>
<td>English</td>
<td>Mathematics</td>
<td>History</td>
<td>Text and Information Management</td>
<td>Drama</td>
<td>German</td>
</tr>
<tr>
<td><em>Sarah</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Business Studies</td>
<td>Japanese</td>
<td>Physics</td>
<td>Biology</td>
</tr>
<tr>
<td><em>Holly</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Outdoor Education</td>
<td>Text and Information Management</td>
<td>Drama</td>
<td>German</td>
</tr>
<tr>
<td><em>Karen</em></td>
<td>English</td>
<td>Mathematics</td>
<td>History of Art</td>
<td>Art</td>
<td>Drama</td>
<td>Biology</td>
</tr>
<tr>
<td><em>Leanne</em></td>
<td>English</td>
<td>Mathematics</td>
<td>Food Technology</td>
<td>Geography</td>
<td>Fabric Technology</td>
<td>Biology</td>
</tr>
<tr>
<td><em>Amy</em></td>
<td>English</td>
<td>Mathematics</td>
<td>History</td>
<td>Text and Information Management</td>
<td>Physics</td>
<td>Biology</td>
</tr>
</tbody>
</table>

Two further girls joined my research group while I was working in the school. Their stories are interesting and I was excited to be able to include their experiences in my research. Helen was in the art classes that I observed and she got talking to me on the way to drama class early on in the research period. She was identified as an extension student at the end of
Year Nine and was accelerated in mathematics for Year Ten and Eleven so has already completed NCEA Level One and Two mathematics. Helen told me that she no longer studies mathematics! I wanted to know more and I asked her if I could add her to my research group and interview her and she agreed and gave consent. Another day I was waiting in the corridor for a first period Text and Information Management (TIM) class with a group of six girls including three of my research girls. One of the other girls, Caitlin, had been in many of the classes I had visited. I asked her if she was doing mathematics and she replied “Yes, vegie maths”. I said, “What does that mean?” and she replied, “The dumb class, we do a mixture of Level One and Level Two work”. Later in the day during Group Time I asked Caitlin if she would like to be involved in my research after explaining what I was doing and giving her the consent forms; she also agreed. Helen and Caitlin’s school subjects were as follows.

Table 2: Additional research subjects and courses enrolled in

<table>
<thead>
<tr>
<th>Name</th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
<th>Subject 5</th>
<th>Subject 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen</td>
<td>English</td>
<td>History</td>
<td>History of Art</td>
<td>Art</td>
<td>Drama</td>
<td>Biology</td>
</tr>
<tr>
<td>Caitlin</td>
<td>English</td>
<td>General Math</td>
<td>Food Tech</td>
<td>Art</td>
<td>Text and Info M</td>
<td>Biology</td>
</tr>
</tbody>
</table>

The school timetable consisted of twenty-five one-hour lessons called periods. Group time was a time where students in the school met with their Group teacher in year groupings. This was a time for school notices to be delivered and forms collected/issued as well as a pastoral care opportunity. Interval was a time for a quick snack and often a meeting time for sports and cultural groups. Period three was followed by Lunch break. Period four and Period five were the afternoon lessons.

<table>
<thead>
<tr>
<th>Period One</th>
<th>8:55-9:55</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Time</td>
<td></td>
</tr>
<tr>
<td>Period Two</td>
<td>10:15-11:15</td>
</tr>
<tr>
<td>Interval</td>
<td></td>
</tr>
<tr>
<td>Period Three</td>
<td>11:35-12:35</td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>Period Four</td>
<td>1:30-2:30</td>
</tr>
<tr>
<td>Period Five</td>
<td>2:30-3:30</td>
</tr>
</tbody>
</table>
Students in Year Twelve mostly studied six NCEA subjects. Each subject occupied four periods in the timetable leaving one period as a Study period.

The original eleven girls were in three different mathematics classes. Ngaire, Harriet, Tara, Polly, Sarah, and Amy were taught by Miss Lord, a young second-year mathematics teacher. Their mathematics class had 24 students in it. Joy, Holly, and Leanne were taught by Mrs Marsh, an experienced mathematics teacher. Their mathematics class had 22 students in it. Vicki and Kylie were taught by Mrs Harris, another experienced mathematics teacher. Their mathematics class had 23 students in it. The Head of mathematics, Mr Morris, taught at Year Twelve, however his class had none of my research girls in it. Caitlin who was in the General mathematics class was also taught by Mrs Marsh. I observed all four mathematics classes as well as a selection of the girls’ other subjects.

**Ethical Considerations**

The thirteen participants in my main study were all girls aged sixteen. As they were not adults it was important that they were fully informed about the research and that their privacy was protected. I sought ethics approval from the university’s ethics committee which was granted. I met with the Principal of the school to discuss the methods that I wanted to employ and she granted me permission to undertake my research in the school. The Head of mathematics was spoken to and he communicated my research plan to the whole staff at the school via a staff meeting. I spoke to all of the teachers that I visited prior to my observations of their lessons. When I arrived at their classrooms I always checked again with the class teacher that it was appropriate for me to visit. I made every effort to keep all of the participants in the research fully informed of my intentions at all times. It was important that all of the participants trusted me in my role as a researcher (Harrison, MacGibbon & Morton, 2001; Guillemin & Gillam, 2004).

I gained signed permission forms from each of the girls and from their parents prior to conducting the research. Consent forms from the parents of the two girls who joined my group during the research process were actioned with urgency even though the girls themselves told me verbally that their parents would not be bothered what they did. Each participant was given an information sheet that informed them of the aims of the study. Each girl was informed of her right to withdraw from the study at anytime and each was asked if they wanted to see a copy of their transcript after the interview; they all declined. I asked each girl for permission to talk to her mathematics teacher and the Head of mathematics about them; they all consented.
Prior to each interview I informed each participant again of the aims of the project and how their interview data would be used (Soltis, 1989). For many of the girls this involved a discussion about what a PhD was about and so on. To protect the identities of the girls I assigned them pseudonyms. I also assigned pseudonyms to the teachers involved in the study. I maintained confidentiality (Orb, Eisenhauer & Wynaden, 2001) at all times assuring the school, the teachers, and the girls that any reporting of the research would be done in an anonymous way.

**Observations**

A combination of methods is often useful because it is difficult for any single method to capture fully the richness of human experience. Because children’s experiences are grounded in their own peer cultures and life experiences, it is especially important that researchers use interviews in combination with other methods, both to obtain more valid responses and to strengthen the analysis of interview data. (Eder & Fingerson, 2002, p. 188)

Observing the girls in mathematics and their other subjects formed a large part of the data collection for this study as “observation sets the ground for the interviews” (Eder & Fingerson, 2002, p. 188). My focus was to observe the girls in their Arts or feminine subjects. With the recent introduction of the NCEA\(^5\) qualification system into the final years of secondary schooling in New Zealand, there is now a greater range of subjects that can be formally assessed. These include subjects such as drama, food technology and fabric technology. Anecdotal evidence suggests that these more traditional feminine subjects are attracting more girls and this may be at a cost to the study of mathematics. When the subject options were more limited, girls may have been more inclined to take a mathematics subject. On the other hand, the numbers of girls are significantly higher than boys in more traditionally feminine subjects such as English, art and languages. I am using the classifications of feminine/female/girls’ subjects to describe school subjects which are labelled Arts subjects (English, history, languages, art) and/or which have been traditionally accessed by more girls than boys (food or fabric technology, drama). The use of the term feminine is problematic because I am constructing a binary here that I am also very critical of.

The Arts or feminine subjects that I visited were: English (4 different classes), History, Art, History of Art, Food Technology, Fabric Technology, Text and Information Management (TIM), Biology, Geography, Japanese, German, Music, Maori, and Drama. These fourteen subjects were the main focus of comparison with the girls’ mathematics classes. These

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\(^{5}\) National Certificate of Educational Achievement, qualifications system introduced in 2002. Level 3 (final year of schooling) began in 2004.
feminine subjects were the subjects that my research girls’ studied in their programmes. There were other feminine subjects such as French and Latin but none of my girls were in these classes. I visited each of these fourteen subject classes at least three times, some more, depending on the timetable. Line C on the school timetable was problematic because it had an English class and a mathematics class in it alongside five of the other subjects in my list: Geography, History, Japanese, Music, and TIM. For me to access each of these classes took a lot of time management over a many weeks to make sure I had enough coverage of each class. I also observed all four mathematics classes that my research girls participated in at least four times each.

I walked around the school, notebook and tape-recorder in hand, conversing with the girls as we went from one class to another. I wanted the students to feel comfortable with me in their school spaces as “a period of field observation can enable the researcher to gain rapport with the [students] prior to interviewing them” (Eder & Fingerson, 2002, p. 188). I aimed to develop relationships with the girls outside of the classrooms. Other students, mostly boys, wanted to know why they could not be part of my research. I had to tell them I was only researching girls this time, however, the reality was that my observations and conversations were just as much about them as the girls; it was just that in the end I was not going to interview the boys. I did not specifically tell the girls that I was a mathematics teacher, as I did not want them to see me as a mathematics expert. They called me by my first name and conversed with me in the same comfortable way that they did with most of their classroom teachers. They were respectful, helpful and interested. They often asked me, “If I had found out anything interesting yet?”

Mostly I observed from a seat at the back of the classroom in the rooms where the seating allowed this. In other rooms I sat by myself away from the students (in drama this meant sitting on the floor as there were no seats) although sometimes the students came and sat next to me as the class progressed. I tried to blend into the background and mostly, after a couple of weeks into the study, this happened in that the students in the classes greeted me but then continued on with their normal classroom activities oblivious to my note taking.

I found that as the weeks progressed I was recording less and less during the lesson, as I wanted to just watch and experience. My notes early on began with every detail of the lesson: what the teacher did, what students were doing at different times, movements in and out of the classroom and within the classroom, where students sat in relationship to others, and details of what was being taught and how the students engaged with the learning process. My main focus was on the research girls in each class but I was always drawn to other events/happenings in the classes involving other students. As time went by I wrote less. My
written record became more about unusual things that happened, or questions I wanted to ask later in the interviews. I found that the times when I wrote more were the times when I missed the most. I realised that the experience of observing was more important than any detailed running record of events; I wanted to experience the space in these classrooms without having my eyes constantly looking down at my notebook.

I sought to compare and contrast different subject areas by observing the girls as they learnt in each class. My observations involved examination of the following:

- The teacher in each subject and their teaching style
- The relationship between the teacher and the students
- The relationships between the students
- The classroom’s physical environment
- The classroom’s social environment
- How the classroom space was used by the teacher and the students
- How students worked in the classrooms as individuals and in groups
- The power relationships within the classrooms
- The gendered behaviours that were displayed.

My overall aim was to observe the differences in these classrooms, not what was right and what was wrong, how events compared to my own experiences of classrooms, and how events linked to other research I had read and critiqued. I was interested in which classroom events/spaces made me feel comfortable and in which spaces I experienced real learning. As an experienced teacher I have spent a lot of time in classrooms but mostly only mathematics and science classrooms. During this research I was able to spend a considerable amount of time in the spaces of other school subjects with which I had little affinity.

**Interviews**

I interviewed eleven of the participants once, and two of the participants twice. The four mathematics teachers and the principal were interviewed once. As Eder and Fingerson (2002) suggest “one clear reason for interviewing youthful respondents is to allow them to give voice to their own interpretations and thoughts rather than rely solely on our adult interpretations of their lives” (p. 181). An additional purpose is so that we can analyse topics in the lives of young people that are not necessarily part of their everyday conversations with each other or the significant others in their lives. I would suggest that talking about mathematics was not
generally an everyday conversation for my research girls, so interviewing them was an important aspect of examining their experiences.

The interview process took place at the end of the observation phase of the study. I employed interviews of the girls and their teachers. I did not have a formal interview schedule, but based my questions on the list above. The interview plan was “flexible rather than rigorously structured and designed to produce as much conversation as possible” (Wetherall, 2003, p. 288). Sometimes discussion and questions in interviews were informed by earlier interviews where interesting points were raised that I wanted to further investigate with other participants. This allowed for “unexpected topics” (Maykut & Morehouse, 1994, p. 87) to emerge throughout the interviewing. Instead of being determined by a formalised, pre-decided structure, the content of the unstructured interviews were shaped by what the respondents told the researcher. The focus was on “reproducing the world of the person being interviewed, not attempting to make sense of it from some predetermined perspective” (Opie, 2003, p. 240). My intent was to make the interviews “closer to a friendly conversation than the stimulus-response model often found in a survey research interview” (Opie, 2003, p. 240).

Although I had certain questions in mind that I wanted to ask I had to be “willing to let the interview develop by allowing opportunities for new questions to emerge based on what [was] shared during the interview” (Eder & Fingerson, 2002, p. 185). I tried to keep the interview-process as flexible as possible which meant that each interview with the participants was different. Although there are similarities in the themes of the interview questions I had no pre-structured interview questions that I asked every participant. I allowed each interview to develop from both my contributions but mostly from what the participants were willing to offer in the discussions.

The researcher has multiple intentions and desires, some of which are consciously known and some of which are not. The same is true of the interviewee. The language out of which the questions are constructed is not bounded or stable; it is persistently slippery, unstable, and ambiguous from person to person, from situation to situation, from time to time. (Scheurich, 1995, p. 240)

As mentioned previously, I often readjusted my questioning based on previous interviews or interesting comments that lead on to different discussion threads. Each interview was thus dependent on the relationship between me, the participant, and all other contributing factors that came together at that particular point in time. Before each interview I read through my field notes of the classes that each girl had been present in. I started each interview by getting the girls to tell me about themselves, their families, their school subjects and so on. I mentioned things I had observed in their classrooms and asked them to tell me
more about each situation. I gently guided them using prompts from the data I had already collected. Where I needed clarification as they spoke I asked for more detail.

There are many “power asymmetries” (Scheurich 1995, p. 247) in the process of interviewing. The relationship between the girls and me was inequitable as I recognised that not only was I an adult researcher interviewing a young person, I was also a teacher interviewing a student, and an author telling their stories (Fontana, 2002). My aim during the interview process was to give the girls an opportunity to tell me about their experiences however often the “abstract structures” (p. 247) of school and society acting upon them during the process may have inhibited their stories. Fontana (2002) sees the interviewer and interviewee as aiming to “become equal partners in a negotiated dialogue” and the “interviewers should indeed encourage all respondents to express their feelings, their fears and their doubts” (p. 168). The interview process aimed for an easy dialogue between the researcher and the participants but often this was made impossible by other contributing factors as will be discussed further on.

There is a belief that many researchers using a postmodern focus need to be open to seeing the resistances taking place in the process of interviewing (Scheurich, 1995). So many things can and do go wrong during the interview process; some due to equipment failure and others due to the interviewees either misunderstanding the questions or even asserting their right to resist the flow of questioning by dominating the interview and thus taking over control of the interview from the researcher. Not all of my interviews were stress-free. Twice my recording device let me down and I had to reinterview the girls, which was far from ideal. I tried not to ask identical questions and wrote down from memory what I could remember from the first interviews to combat this problem but the interview data was compromised and I felt that these two interviews became missed opportunities.

At times it was difficult to find a quiet space to undertake the interviews, often the girls themselves made suggestions. Eder and Fingerson (2002) state, “one of the most important considerations in interview research with young people is the creation of a natural context for the interview” (p. 183). Some of the girls wanted to talk to me out in the sun; this made for a relaxed interview but affected the sound quality of the recording. Another girl, wanted to talk to me while her friends waited nearby. This resulted in the friends getting impatient with the time the interview took and continually disrupting us. These examples illustrate Scheurich’s “dominance-and-resistance view of the play of power” (p. 247) in the interview process. In the course of trying to make the interview comfortable for the girls I may have compromised the collection of worthwhile data.
Some of the girls did not want to miss class to be interviewed and these interviews had to be conducted after school, which meant reducing their social time. Others had after-school jobs or sports/cultural activities and it was difficult to find any spare time with them at all. Karen had a supermarket job interview the day I had organised to interview her. She really wanted to meet with me so her mother and I organised that I would drive her to the job interview after our meeting. Our interview ended, the tape was turned off, and then on the drive to the supermarket she spoke much more openly about school and her experiences of school than she had while the tape was on. As soon as Karen left my car I turned the tape back on and recorded as much detail as I could about our car conversation.

I believe I became a better interviewer as the research process progressed; however, I believe that interviewing young people will always be a difficult process fraught with issues of power and representation. This is an issue in any interview, not just with young people, an example of which was my working with one of the mathematics teachers, a young beginning mathematics teacher who after learning I was a mathematics teacher became nervous with me in her classroom and during the interview. This can be described as the “elastic subject position” (Fontana, 2002, p. 167) of the respondent. The young teacher’s subject positioning may have altered when her view of me changed from being the researcher into the mathematics teacher. The suggestion is that “although interviewing can add important information to participant observation studies, researchers should also be aware of the limitations of interviews. There are aspects of [participant’s] cultures that are difficult to put into words” (Eder and Fingerson, 2002, p. 189). Many teachers are uncomfortable with other teachers/adults in their classrooms. Many research subjects tell us about their lives and experiences and it is important to reflect on the notion that this conveying of their lives to researchers does not occur in a “social vacuum” (Fontana, 2002, p. 167). Accepting a researcher into a classroom may be easier for teachers when they believe that the researcher is only there to observe the students. Seeing me as a mathematics teacher observing a mathematics lesson may have changed the power positioning between the young teacher and me. Narrative activities produce consistency in everyday events but also make visible differences, this coherence and disparity of experience is a goal of the research process.

**Visual Data**

Fontana (2002) talks about allowing “diverse voices” (p. 164) to appear in our studies, but also suggests that mixed methods add significantly to the data. Other researchers have used their own stories and visual imagery to enhance the research process. For many
researchers this process of using many sources of data and bringing it all together to make a “confirmatory edifice” (Fine et al., 2000, p. 118) or a stronger case is called triangulation (see Coll & Chapman, 2000, Denzin & Lincoln, 1994, Massey, 1999). In feminist poststructuralist theory there is no aim to find out *truths* by using any particular method (Davies, 1997b; Jones, 1997); however, multiple methods allow for a more detailed picture to be taken to capture any given situation.

Alongside data attained through the observation and interview phase I also collected visual data in the form of digital photographs of the classrooms that the research girls were present in. These photographs complemented the sketches of the classroom layouts that I recorded in my field notes. Many photographs were taken without students present to protect the identities of the participants and others in the classrooms. Where students/teachers were present in the photographs, I have used photo-editing software to blank out any identifying characteristics.

Although social research typically involves the use of “complex theoretical and abstract questions” (Loizos, 2000, p. 93), the use of visual information can inform our understandings without the use of any words or numbers. The influence of the visual impacts on young people in every aspect of their lives, that is, television, the Internet, electronic gaming, virtual social networking, and so on. To ignore the visual aspects of classroom life, I then believe, would be a disservice to our students, when they live in social worlds full of visual impacts. Using visual material is not unproblematic as they are merely “representations or traces of more complex actions” (Loizos, 2000, p. 94), a two-dimensional view of a three-dimensional social world of, in my case, classrooms in a school.

A “common fallacy about photography is that it is simply and universally accessible to everyone in the same way – that it operates transculturally, and without regard for social contexts, in such a way that everyone will both see *and perceive* the same content in the same photograph” (Loizos, 2000, p. 96, original emphasis). Everyone who views a photograph identifies different details as related to their subject positioning and their view of the usefulness of the photo. A photo is not unambiguous; how I see the detail differs from how someone else may see it. What I am searching for in the photos is influenced by my subjectivity as a researcher trying to gain additional data from this visual source. We can make casual inferences from photos but these inferences are not secure knowledge as any interpretation of visual data requires “reading both the presences and the absences” (Loizos, 2000, p. 101) of what has been photographed. It would be neglectful to let any visual data constrain or overshadow a research study when scrutinised alongside other methods of data collection remembering that a camera always “observes from a fixed position” (Loizos, 2000,
p. 104) allowing the capture of information at only a particular point in time and in a particular place/space. In contrast, Zevenbergen (2005) likes that photographs can be used to follow a person around, that is, that the equipment is not fixed and is thus able to be quickly adjusted and moved so that it is not as intrusive as say a video camera placed in the corner of a classroom.

The analysis of the digital photographs and classroom plans was conducted with reference to the work of Rose (2001) and Pink (2001). The visual record has provided a rich source of data about physicality and positionality within the classrooms and has become an important focus during the analysis phase of the research as a source of ‘remembering’ what things looked like. The visual representations have helped to emphasise some clear contrasts between the arts subjects and mathematics classrooms that the girls attended and complement the spoken and written records.

**Giving back...tutoring and follow-up interviews**

Some sort of reciprocity can be an important part of the research process (Eder & Fingerson, 2002; Harrison, MacGibbon & Morton, 2001). One form can be giving something back to the research community (Fine et al., 2000). I decided that I wanted to give something back to my research girls while they were in Year Thirteen, the year following the main study. I approached the HOD of mathematics early the following school year and offered to tutor any girls doing mathematics in Year Thirteen (statistics or calculus). Together the HOD and I examined the timetable for my fourteen research girls. Of the fourteen girls, three were doing Year Thirteen statistics (Vicki, Polly, and Amy) and one was studying Calculus (Ngaire). Helen had already opted out of mathematics for Year Twelve so, as expected, she had not re-engaged with mathematics in Year Thirteen after a year off.

I went into the school for one lunchtime every week. The tutoring session was offered to any girls in Year Thirteen mathematics, not just my research girls. For a few weeks Polly and Ngaire attended with Amy. Vicki never came to a single session and after a few weeks in only Amy continued. No new girls took up the tutoring opportunity. I worked with Amy for most of the year one-on-one. We worked around her timetable and towards the end of the year I asked her if I could re-interview her. Amy suggested doing the follow-up interview in my office at the University at a time to suit us both. I also wanted to interview one of the girls who had not continued with mathematics. Amy suggested Leanne, a friend of hers, and I re-interviewed Leanne at her home at the end of the year also. The follow-up interviews
promoted a “greater level of depth” (Eder & Fingerson, 2002, p. 186) and a chance for these girls to self-reflect on their previous interview and experiences.

**Analysis of Data – A reflective response**

As the interviewer comes to realize that she is an active participant in the interview, she must become reflexive, acknowledge who she is in the interview, what she brings it, and how the interview gets negotiated and constructed in the process. (Fontana, 2002, p. 168)

The observer in social science research has in the past been seen as a “potential contaminant, something to be separated out, neutralized, minimized, standardized, and controlled” (Fine, Weis, Weseen & Wong, 2000, p.108). As researchers we can never be absent from our texts and the “inclusion of [our] subjective experience” (p. 109) needs to be approached with care. As researchers become more and more self-reflexive attention must be paid to concerns that we can lose sight of those whom we are trying to represent in our writing because our own experience and expectations condition us to respond in specific ways. Fine et al. (2000) write about the positioning of the stories we as researchers tell:

We err on the side of telling many kinds of stories, attached always to history, larger structures, and social forces, offered neither to glamorize nor to pathologize, but to review what has been, to re-imagine what could be . . . and to revisit, with critical speculation, lives, relations, and communities of privilege. (p. 126)

Sometimes telling the stories of others can result in the researcher having to re-examine how they have always thought about the world they are studying. For me personally, this means critically examining my own teaching practice through the eyes of girls who could have quite easily been students of mine. They may, at times, have threatened my own perceptions of mathematics classrooms and mathematics teaching. This compelled me to make changes to way I had always done things in the past. I thought I was always operating under a personal regime of best practice that possibly was not suited to all of the learners in my classrooms.

Reflecting on our research data requires analysis of the context in which the participants were situated. We also need to recognise that “different people do, in fact, seem the same but different at times” (Fine et al., 2000, p. 126) and that often the mundane, everyday activities need a close focus as we “enter the scene looking for stories” (p. 117) always aware that the texts that are produced have multiple interpretations with a feminist poststructuralist emphasis on “contradiction, heterogeneity, and multiplicity” (Fine et al., 2000, p. 119). We need to
address issues such as who have we “silenced” (p. 127) in our telling of the stories and whether we have blamed the right person/social structure based on the information we are given. Fine et al. (2000) emphasise the “murky swamps of self-reflective “writing stories”” (p. 128) and suggest that researchers must always be aware of:

The pulls, fantasies, projections, and likely responses of very different kinds of audiences and the responsibility we have, therefore, to anticipate the relation between the texts we produce and the “common sense” that awaits/confronts them. (Fine et al., 2000, p. 127)

Those who direct curriculum decisions, those who prepare examination assessments, those who manage schools, and those who teach mathematics may not like being informed through this research that what has been deemed the norm in mathematics education does not suit all learners, especially some girls.

As I write, it will of course be in my own voice; however, my aim is always to avoid being “complicit with dominant representations which reinscribe inequality” and with a concern for “power and positioning” (p. 119). I aim to weave the voices of my research girls in with relevant theoretical framings, but minimise this so that their voices can still be heard. I want to examine the “hegemonic voices [and] create textual room for counter-hegemonic narratives” (p. 120) so as to represent them accurately but at the same time dismantle the social constructs which position them in their daily experience of school mathematics.

After each interview I listened to the recording. The interviews were transcribed and then I listened to them again to check the accuracy. Each time the transcripts were read through later for analysis I kept the tape recordings by me to check for details not always apparent in the transcript such as pauses, emphasis on words, and so on. I did not transcribe the recordings taken from within the classrooms. However, I continually referred to them as I analysed the other data such as the transcripts, field notes, and photographs. Whenever I needed clarification of what was happening at a particular time in the classroom I returned to the raw audiotaped data.

Researchers need to “display a greatly heightened sensitivity to problems and concerns that previously had been glossed over or scantily addressed” (Fontana, 2000, p. 162). After conducting the interviews, the resulting transcripts were analysed for key themes, including any evidence of discursively produced binaries (Davies, 1997a, 1997b), using discourse analysis (Cameron, 2001). Discourse analysis goes beyond an analysis of content to “uncover the larger patterning of thought and structures the way language is used, and more specifically, how the meaning of that language was created, reproduced, and interpreted by those involved in its use” (Tolich & Davidson, 2003, p. 129). Experience is “discursively
constructed, made and remade as people talk about things using the discourses they have access to” (Cameron, 2001, p. 15). Discourse analysis is a process for exploring the “social voices” (p. 15) available to the girls whose talk I collected.

Discourse analysis is not exclusively concerned with the spoken word; it deals with “socially situated language-use in any channel or medium” (Cameron, 2001, p. 7). This means I was able to examine all data sources in my research using methods associated with discourse analysis. My aim when analysing the data was to look for “regularities” (Wetherall, 2003, p. 289), that is, recurring words/themes that appeared throughout the transcribed interviews. I used cut and paste to put what I considered to be broader themes together in new documents; these later became the basis of the three findings chapters. I was particularly interested in words/themes where there was an obvious opposite word or thought, for example, ‘maths was boring’ or the word ‘hate’. Discourses can grow around a specific topic and they can compete with each other or “create distinct and incompatible versions of reality” (Davies, 2000b, p. 88). The girls in this research could only experience mathematics through the “categories and concepts available to them in discourse” (p. 89). It is argued that poststructuralist critical discourse analysis disrupts the “binary between text and con/text” (de Freitas, 2010, p. 148) allowing for an honouring of the “multiply constituted and entrenched” (p. 149) material conditions of the girls’ experiences of mathematics. There is a combination of both analysis and interpretation at the fore of this helping to “expose the discursive mechanisms of symbolic domination whereby some students are positioned “outside” the text of classroom discourse” (de Freitas, 2010, p. 149). The aim was to “understand how and why these binaries, these categories of analysis, these “others”, these splittings, and these accusations” (Fine et al., 2000, p. 120) were produced for the girls in the space of their mathematics classrooms.

Conclusion

This chapter described the research design for this study. A pilot study, with one female participant, was undertaken to trial the research methods and identify potential pitfalls. The main study involved thirteen Year Twelve girls who studied mathematics at school alongside a selection of other feminine subjects. The girls were observed in their classes and then interviewed about their experiences. Interviews were also conducted with their mathematics teachers, the HOD of mathematics and the Principal.

Background information about the girls subject choices and how consent to participate was gained. The research methods included lesson observations, semi-structured interviews
and visual data in the form of digital photographs. The photographs provided a representation of the classrooms to refer to during the analysis of the transcript data. Consideration was given during this research to giving something back to the research school in the form of tutoring. Analysis of the data was approached using discourse analysis through a feminist poststructuralist lens. The identification of discursively produced binaries made up a large component of the analysis as well as close examination of the spaces in which the girls were constructed. Reflexive approaches were employed where I acknowledged my subjective positioning throughout the research process.

“The context in which we write today will change tomorrow, and so too will the readings of this text” (Fine et al., 2000, p. 125). Nevertheless, the stories are good stories, they may be “always partial but/and deserve a hearing” (p. 125). The girls in my research group may be survivors or “individual heroes” (p. 125) if they struggled with many issues in mathematics and then still chose to continue on with mathematics even though they knew they did not like it or that it would be a struggle. The issues involved are complex and warrant this research being undertaken and analysed. The following chapters examine the data and unpack the stories of these research girls taking into consideration all of the above issues and constraints.
CHAPTER FIVE: CONSTITUTING
SCHOOL MATHEMATICS

This chapter addresses the research questions “What are girls’ experiences of secondary school mathematics?” and “How do girls’ experiences of mathematics compare and/or contrast with their experiences of their other secondary subjects?” I will examine the research girls’ experiences of school mathematics and their other subjects using data drawn from their transcripts, their teachers’ transcripts, and my field notes. The key areas that will be covered are the students’ perceptions of school mathematics pedagogy, including the use of and positioning within classroom space (Holloway & Hubbard, 2001), with comparisons to their other subjects.

This chapter also examines discussion and group work in mathematics as well as the use of practicals in mathematics and the practical uses of school mathematics in the girls’ lives and futures. The students have 'constructed' the world of mathematics for me, the researcher. These experiences are richly described through the students' eyes and I am constructing it so the reader can imagine the world of the mathematics classroom in this research. The girls’ experiences of their lived mathematics education captures the “complex and changing processes” (Brown & Walshaw, 2012, p. 4) in which their subjectivities and their mathematical knowledge are constructed. This chapter may not capture all aspects of their reality and will not assert causes, but it will examine the contexts in which the girls find themselves and the arrangements of power that position them in their mathematical experiences at school.

**Pedagogy**

I visited four mathematics teachers and their classes at least ten times per class during my time in the research school. The girls gave me accounts of their experiences in their interviews, however, sometimes their descriptions of events in the classes differed from each other and from my observations. Three of the classes were doing the same topics at the same time, which gave me the unique experience to observe how three different teachers approached their teaching. Each class had slightly different working environments as far as noise levels, engagement and seating arrangements but the content was all taught in almost exactly the same way right down to the structure of each lesson. This structure involved a ten-question starter activity on the board, some teacher-directed instruction and notes, and then either a worksheet to do or an exercise from the textbook. This classroom ritual can be
described as a “regulatory practice of teaching” (Walshaw, 2010, p. xi), where the teacher controls the classroom programme and flow of the lesson.

During the worksheet or textbook activity the teachers would usually walk around the classroom. Circulating around the classroom while the students were completing a worksheet or textbook exercise is still seen as the teacher invoking an “institutional authority in interactions” (Brantlinger, 2014, p. 214) that is, the teacher is attempting to hold the power over any resistance to the set work. This reflects the ideas around domination and subordination in space (Massey, 1992) where the dominant position was held by the teacher controlling the classroom interactions. My impression was that only one class had a real focus in it and some (not all) of the students appeared to be learning. I would suggest that the majority of the students in the mathematics classes were just going through the motions, listening when required, doing exercises only if closely monitored, and taking every opportunity that they could to get off-task. Specific discursive practices were highlighted through the use of specific teaching methods, teaching materials and the classroom setting, however, the students subjectivity positioned themselves as intentional or non-intentional learners (Stentoft & Valero, 2010), choosing when to partake in the regular classroom discourse.

Noise levels were often quite high and most of the teachers struggled to reign in the students to give instructions or fully explain the content. It has been shown that students cannot learn in chaotic classroom environments where the students are poorly managed (Marzano & Marzano, 2001). This non-mathematical interaction could be seen as the students’ “resistance to learning” (Stentoft & Valero, 2010, p. 91), because there is no guarantee that students will learn just because teaching materials are provided. Most of the students were sitting in pairs facing the front. They interacted within the pairs or with another pair either in front or behind. Sometimes the discussion was work related to the tasks but more often it was social interaction. These students were interacting with each other so as to “construct, disrupt, and resist meanings and understandings” (Edwards & Usher, 2003, p. 5). Often the teacher appeared to assume that the students were working on the tasks she had assigned, but my observations suggested they were resisting this and using the space in mathematics to assert their social selves. This was a disruption to the intended power of the teacher, as she did not hold the power and authority that she may have believed she held (Shilling, 1991).

Classroom noise which disrupts learning emphasises how unstable and unpredictable the mathematics learning environment can be (Stentoft & Valero, 2010). I did not observe any full class discussions in any of the mathematics classrooms Sometimes there was some closed
questioning, that is, the teacher asking for an answer from an individual student, during teaching periods at the start but I rarely observed a student in mathematics actively engage with the teacher in discussion. Some students worked well on-task completing all of the work but the teachers often ignored them as they wandered around the classroom. The focus of each mathematics teacher was mostly on noisy or off-task students.

What follows are some of the girls’ descriptions of what happened in their mathematics classes. Harriet talked to me about her mathematics teacher from the previous year as well as her present teacher.\(^6\)

I: Can you tell me what it was about last year that made it difficult for you to learn those things that you wanted to learn?

Harriet: Well I think the teacher I had was just, she was sort of, I don’t think she had a teaching, not necessarily a bad teaching style but just one that I didn’t really, I couldn’t really learn easily from. Because basically she would put stuff up on the board and then she would talk about it for a while and then we’d write it down and then but we wouldn’t really do any examples and the thing with Miss [this year’s maths teacher] is we always do two or three examples of every question and I find that it helps me in all classes. Like in chemistry um I’ll need the teacher to go through step by step what we’re supposed to be doing so that I can learn it. Miss [maths teacher] does that in maths this year and it’s really good.

I: So her style is, how does she teach you?

H: Um well we’ll go through sort of the basics like take trig, we learn Pythagoras theorem again although we did learn it last year and um so we’ll go through the basics and even though we probably won’t need Pythagoras theorem too much in the exams we still sort of need it to build onto other things so she starts at the very beginning and sort of moves us up. Even if it’s for a little bit to remind us what’s going on.

I: Mmm and you find that helpful

H: Yep, definitely.

What this extract shows is that pedagogical devices are more than just an environment, they are “imbued with a complexity of relationships evoked by the users and the underlying discourses” (Calder & Brown, 2010, p. 225). The underlying discourses in Harriet’s experiences were related to the helpfulness of the work given to her by her teacher. I find it interesting that Harriet believes that her present teacher is better than last year’s based on how she gives more examples and revises the previous work before moving on. For Harriet it was important not to advance onto the new work until she could see how it tied into what she already knew. This provided Harriet with a positive experience because she remembered last

\(^6\) The transcripts shown are all unedited.
year’s work, for example, Pythagoras, and this helped to make her more comfortable before engaging with the new more challenging work. Harriet also liked examples to look at.

This is a common discourse that threads through much of the data and is my own teaching experience as well. Students like to have worked examples that they can refer back to as they work through a worksheet or a textbook exercise. Unfortunately, the disadvantage of this is that often they can be thrown by a new problem, especially a longer, context-based word problem, when it does not quite fit with the worked examples they have in front of them. Too often students focus on the procedures of mathematical problems rather than the interpretive skills to analyse a problem and identify which methods they have learnt can be applied to the task in front of them (Boaler, 2009). I would suggest that the step by step approach that Harriet liked prepared her well for the achieved level assessment questions in NCEA but that her struggles with mathematics, that she told me about, may have been because she was not able to use these basic skills to interpret questions at the higher levels.

Although many of the students are like Harriet and may find it easier when mathematics is taught in a procedural way they may not realise that this style of teaching is not preparing them for environments where they are expected to problem solve, analyse, interpret, explain, and discuss. Calder and Brown (2010) call this the ‘best practice’ versus ‘good teachers’ binary because here the assessments hold the authority or power and it produces a teacher in a particular way where they may want to please their students by teaching them the basic knowledge. However, this may leave them with gaps in their higher-thinking skills such as reasoning and justification. Inquiry instruction and conceptual investigation may be overlooked so that there is an overwhelming emphasis on the mastery of procedure (de Freitas, 2010). The impact of this is that the students may be positioned as students only capable of reaching minimal levels of achievement in mathematics because they are constructed to learn mathematics in a disjointed way and they may not feel they can apply their knowledge in new situations.

Joy did not like her mathematics teachers and much of her dislike was not a personal dislike of the teacher, but more related to aspects of the teacher’s lack of control of the rest of the class.

Joy: Um, well, the teachers were different anyway, so, I had a bad maths teacher last year, which was yeah.

I: So what happened, what made the teacher bad?

J: Um, I couldn’t learn off her, just like I couldn’t learn off Miss [teacher] this year.

I: So do you think the teacher makes a difference?
J: It does.
I: So if you could pick your ideal maths teacher that would suit you, what would they do that would be different?
J: Um, I don’t know, maybe catch your attention. I’ve no idea really in maths.
I: So is it not interesting enough?
J: Um, no, it’s just that she can’t control the class, and we can’t pretty much hardly hear her anyway, over all the noise, so.

Joy expressed how the teacher made a big difference to how she learned in mathematics. She mentioned how if the teacher could “catch your attention” then it might make a difference to her experience. My observations of the mathematics classrooms were that the teachers often put up ten question starters on the board as a form of ‘catch them’ at the beginning of each lesson. This starter idea was something I experienced in my teacher training in the late 1980s and in many professional development courses post-1990. The idea was to provide some sort of engaging activity at the beginning of a mathematic lesson to get the students’ attention and to provide a pathway into the following lesson. Unfortunately, many teachers translated this idea into putting up some revision type questions on previous work and using this as a settling time for the students as they enter the classroom. The practice of using starters as “consolidation tasks” (Anthony & Walshaw, 2010, p. 2) still occurs in many mathematics classrooms and has been shown to consume approximately 20 percent of overall lesson time (Anthony & Walshaw, 2010).

This style of beginning a lesson was used by all of the mathematics teachers I observed. Often the lesson started with very procedural type tasks and relied on recall of some fairly basic facts or skills learnt in previous lessons. The settling effect did work sometimes, but if the questions were too difficult then the students just had to sit and wait until the allocated time was up and the teachers then went through the answers on the board. Sometimes the teachers would ask a few students to contribute to this process but mostly they would just write up the steps, if any, and the answer. There is the suggestion that if the students perceive learning obstacles in the mathematics classroom, as in questions on the board being too hard, then they will feel they do not have a meaningful personal role in the classroom (Stentoft & Valero, 2010). This may shut down learning possibilities; positioning the teacher as powerful once again.

Joy’s mathematics class was a particularly noisy class and, as she suggested above, the teacher did not appear to have good control. One idea of what constitutes a good mathematics teacher is that they are seen as a professionally competent expert, or in simple language a real
Joy and Leanne were in the same mathematics class. Unlike Joy, Leanne wanted to continue with mathematics the following year even though she found mathematics difficult at times and perceived herself as not doing very well at it.

I: If you were starting this year again, or you knew someone who was starting Year 12 again.
Leanne: Like a Year 11?
I: Yeah, what kind of advice would you give them?
L: Don’t stop listening (laugh), um yeah, probably just you know keep up with your work and you know.
I: Was it hard for you to stay focussed?
I: Do you think there’s anything that the teacher could have done to make that better for you?
L: I mean if I wanted to do well I probably would’ve done it, um, I can’t really blame them for me stop listening. But um, probably not, its just sort of, and like my fault its like ahh what? Because you know I chose that [maths] for this year and I got my timetable and it was like, please no, that’s not her initials. You know, what’s wrong, um yeah, that was really annoying.

Leanne appeared disappointed when she found out which teacher she was going to have for mathematics that year. She seemed to have a perception of this teacher already. I am not sure whether she had been taught by this teacher before or whether she had an idea about the teacher that she had heard from others. My reading of the transcript above is that Leanne had not been very focussed in mathematics during the year. She referred to this by her use of the words “lack of motivation” and “stop listening” and “keep up with your work”. These phrases imply that Leanne herself had not done this. If we look at the binary opposites of these: work hard, listen well, and do all the work, then Leanne is suggesting that she knows what was required to improve her mathematics results but that she was disengaged for most of the year. Even though Leanne does not directly state that she does not like her mathematics teacher this is implied by her use of the word “please no” and “that was really annoying” when she discovered from her timetable that this particular teacher was to teach her mathematics this year. This appears to have had an impact on her experience of mathematics right from the
beginning of the year. Unlike Helen (see Chapter Seven), Leanne did not switch classes so that she could be taught by a different teacher, she stayed in this class and appears to have not enjoyed mathematics for the year.

Leanne was able to tell me how her teacher in Year Twelve differed from her teacher the previous year.

I: So what was different about last year, in Year 11?

Leanne: Um, probably my teacher, and I didn’t stop listening (laugh).

I: This keeps coming up, the listening thing, but tell me about what was different about the teacher?

L: Um, he was sort of like, write the notes on the board, or have them written, and then explain to us and then you know go through with us a bit, and then tell us to write down the notes so we’d understood what he was talking about. And then we would do work from the textbook. Whereas now its sort of like, sometimes she’ll give us, more, its more at the start of the year not so much now, she’d get us started and then like, we hadn’t done it before and if we couldn’t do it then we’d get explained how to do it. Which I’d rather sort of explain first then give us the work. Um yeah, I just thought last year was better.

I: I get the impression that one person is helping you through it first and the other is trying to get you to work it out a little bit yourself.

L: It is hard like to do different things, like listen to her explain it while trying to understand it, while writing it down. Its kind of hard I think.

I: Mmm, and then that, does that impact on the rest of the lesson?

L: Yeah, well I don’t understand it and I have to go through it and don’t get it, and then I just ask her you know I don’t get it, and I still don’t understand it, and then I couldn’t do the work.

Leanne, like Harriet, expected mathematics to be taught in a particular way and did not believe that her teacher in Year Twelve was doing it right. Leanne’s view of what was happening in her mathematics class and my observations were often in disagreement. She wanted the procedures of her previous year’s teacher, that is, notes on the board, go through the work, do some examples from the textbook. She did not perceive that this year’s teacher was doing this but my observations in the class were of these same procedures each time I visited. I am not sure why Leanne thought the teacher was doing things differently. I wonder if it was more to do with the pace at which the teacher may have needed to cover the work in Year Twelve compared to in Year Eleven. There is certainly a big jump in the level of the content in Year Twelve and also a lot of different and new topics to get through during the year. It appeared that Leanne may have needed more thinking time during the lesson, a chance to work through the detail of the new work before she progressed on to the exercises
and that she was not feeling supported enough to do so. Leanne also implied that she asked for help but did not think that the teacher helped her to understand the work. Earlier, Leanne admitted that she may not have listened enough or worked hard enough so it is difficult to really know if it is the teacher at fault or Leanne at fault or maybe the of the type of mathematics she was forced to learn at school (Johnston, 1995). Leanne’s view of herself as not doing well reflects the notions of responsibility attached to “personal circumstances, choice or ability” (Klein, 2004, p. 40). The suggestion is that girls are made to feel that is their problem and that all they need to do is change their attitude. The “absolute authority” (Klein, 2004, p. 40) of the teacher positions Leanne as a learner who needs to make changes for herself if she wants to succeed in mathematics.

Interestingly, my observations of Leanne in her classes showed a young woman who played very different roles depending on the subject. Leanne appeared confident and in control of her own learning in fabric technology. The other girls in the class relied on her for assistance with their own work, often in preference to the teacher. Leanne was helpful and she guided them to a solution when they had difficulties with their projects. Consequently, I saw her very much as a leader in fabric technology. Similar behaviour was not apparent in my observations of Leanne in mathematics. She was often seen to be asking the boy who sat in front of her for assistance with her work and she rarely attempted the exercises without calling on this boy to check that she was on the ‘right track’.

Leanne’s role as a helper for others is what Walkerdine (1990) terms a “subteacher”. Leanne takes up the position of being nice, kind, and helpful in fabric technology. Walkerdine (1990) suggests that this is how many teachers describe the girls in their mathematics classrooms but I observed that whereas Leanne fulfilled this role in fabric technology, it was the boy who took on the role as helper in the mathematics classroom.

Another interpretation could be that she is taking on the “position of teacher” (Walshaw, 2001, p. 10) in fabric technology which Walshaw (2001) suggests actively places her in a powerful position in the class instead of the usual position of “the powerless female learner” (p. 10). However, this then suggests that in mathematics Leanne was positioned as the “powerless female learner” which maintains her as a “passive and dependent product” (Walshaw, 2001, p. 10). Walshaw (2001) also points out “relations of power are continually changing” (p. 10); Leanne was relatively powerful in fabric technology but powerless in the mathematics classroom, depending on how her subjectivity was constituted.

Harriet also talked about needing help in mathematics and how that contrasted with her role in English.
I: So can you be more independent in English?
Harriet: Um, I can, because has always been pretty easy for me but I have to ask the teacher or Polly for help a lot in maths and I don’t do that in English. In fact I’m better than Polly in English and everyone asks me for help.
I: So your roles quite different depending on what class you are in?
H: It’s maybe just me. I mean it depends what people are good at.

Davies (1997b) discusses how “the inhabiting of one image or another is fluid” (p. 12) and this is reflected where both Harriet and Leanne’s discursive positionings changed between their two subjects. In fabric technology, Leanne is visible and has agency, that is, she can take some control over her learning as well as inhabiting a position where she can help others. This was similar for Harriet and, it appeared that, Harriet was proud that she was better at English than Polly. In mathematics, both Harriet and Leanne were invisible, a stark contrast to English for Harriet and fabric technology for Leanne. Leanne and Harriet may have become “detached observers” (Nespor, 1997, p. 121) within the spaces provided in mathematics. They existed in the space, but in a way that positioned them as isolated from things happening around them (Massey, 1992). They existed in subordinate positions, in particular, to the boys, and to the teacher, who occupied the positions of power by dominating the space in the classroom; the boys with their often off-task behaviour and the teacher with her style of at-the-front of the class, teacher-directed learning. Although Leanne herself did not discuss differences in how she learnt in the two subjects, it may be beliefs about their feminine and masculine nature did influence what she felt were her options for involvement.

Joy and Leanne were in a different mathematics class to Harriet. However, just like Harriet’s class, for a large part of the mathematics lesson, the teacher instructed the class as one group from her place at the front of the room, by the whiteboard. This mathematics classroom was often a place of chaos; loud, noisy behaviour, inattentive students, and a large amount of time spent on off-task behaviour. Often chaos is used to disrupt the order of the curriculum, students using their agency to take back a sense of control of their own learning environment (Massey, 1992). The lessons, although structured, were similar in style from one day to the next, and followed a fairly traditional approach to disseminating mathematics to the students. This routine involved: a ten question starter written on the board, going through the answers, some teaching of the new work where the teacher told the class the new work and a follow-up exercise from the text book. Classroom culture often reflects how the curriculum is presented and when students work from textbooks and worksheets they may feel that their
learning is repetitious, separating them from their classmates and positioning them as an individual learner disconnected from their classmates (Angier & Povey, 1999).

During the textbook exercises, the teacher moved about the classroom but her main role during this time was to maintain order in the classroom. I believe that it was because of this that Leanne and Joy were required to obtain assistance with their work from the boy sitting directly in front of them. The teacher was often elsewhere in the room dealing with disruptive students and thus unavailable to them. In this mathematics classroom, these distracters were mostly boys, or the girls sitting with the boys. Most of the teacher’s time and energy was used on this small group of students.

This contrasts with the fabric technology classroom, in which Joy and Leanne were together again, where the teacher’s main role was as a facilitator. The students, all girls in this class, came into the room and went directly to their work. They knew what was required of them and began working on individual tasks. My field notes recorded that the classroom had an “independent atmosphere” but that these students were also able to work and chat at the same time. Sometimes this chatter was task-related, but not always. The difference with the mathematics classroom was that they could stay on-task with their projects and converse at the same time. The students were able to move about the classroom to seek assistance from the teacher or from each other. They were able to ‘bounce’ ideas off each other, try on the garments they were producing, and provide constructive feedback to each other. The environment was not only collaborative but supportive and safe. I noted, “every girl in this class is completely on task. There is a peaceful, quiet atmosphere in the classroom. Everyone treats each other with respect, helping each other”. In fact, the teacher at one point asked them if they wanted the radio on, and after a positive response, turned it on so that there was background music throughout the lesson.

The mathematics class and the fabric technology class share similar traits with the two mathematics classes investigated by Jo Boaler in the 1990s (Boaler, 1997a). The mathematics classes that Leanne and Joy attended showed many of the traits seen in Boaler’s Amber Hill classrooms. Boaler believed that girls underachieved in this environment. On the other hand, at Phoenix Park, students were involved in project work in their mathematics classrooms and these projects shared similarities with how Leanne and Joy worked on projects in their fabric technology class. At Phoenix Park, although many students at any one time would be wandering around the room and chatting about non-mathematical things, more students passed the GSCE examination than at Amber Hill. Girls at Phoenix Park performed as well as boys and “talked about the way that mathematics allowed them to conjecture and predict, to think, to use their own ideas and to use their “personal” experience” (Boaler, 1997a, p. 337).
The students saw the approach adopted in maths as being most closely related to how their arts subjects were run.

The mathematics classroom that Leanne and Joy occupied was more of an inhibited environment, controlled by the teacher acting as an “all-knowing disseminator of knowledge” (Mau & Leitze, 2001, p. 40). Students rarely contributed to the curriculum-related classroom discourse. Chapman (2001) calls this more authoritative mode of speaking mathematics “boys’ talk” (p. 200). In contrast, discussing, explaining, reasoning, and collaboration are perceived as girls’ talk (Haynes, 1994).

Being a student in mathematics may be learnt through the experience of involvement in mathematics’ classroom discourses over time. These discourses operate within “regimes of truth, not because of their power to describe reality but because of their power to produce it” (Mendick, 2006, p. 18, original emphasis). Often the teachers revert to models of instruction that are methodical and routine and they ignore the diverse learning preferences and styles of the students in their classrooms. Analytical type instruction has been seen to favour males more than females (Fox & Soller, 2001). The suggestion is that mathematics classrooms may need more hybridity, a strategy that may create more lively and appealing learning environments (Davis & Williams, 2009). Including broader aspects of social interaction and context in their mathematics learning may encourage greater engagement by all students.

Tara talked about two of her other subjects, History and English, and contrasted these with her experiences of mathematics. Like all of the other girls in this research, mathematics was not her favourite subject. This is a large section of transcript but I have included it because there are a lot of interesting and overlapping discourses within it.

I: What’s your favourite subject?
Tara: Um, probably history.
I: Why’s that?
T: Ah, just love it, I’m really interested in how things came about today and especially about cultures in other countries, I don’t know, I love it, I don’t mind studying for it, I like reading it, something I don’t mind at all, I enjoy it.
I: So what happens in history that makes it different from something like maths?
T: It’s, well its based on people, how people think, how people feel, reactions to things and events and such an interesting subject, countries, the whole country, or it’s war and harmony.
I: So what’s your teacher like?
T: He’s teaching away and then he gets really into it, he’s really passionate about it, and that’s probably why I end up enjoying it so much because
he really, really loves teaching it, and you know he puts on voices at school and he has an accent, I think he’s a really good teacher, he sometimes doesn’t really get around all the kids but you don’t really need his help anyway because you know what you’ve got to do, its not hard, its good.

I: And do you work with other people in that class?
T: This year, it’s more, you know individual, reading textbooks, answering questions and then just talking about it so yeah more like class discussion.

I: And what’s English been like this year?
Tara: Its been good, fun.
I: And so what are the things you like about?
T: Just that I can do it, and I don’t struggle with it like maths.
I: Is maths a bit of a struggle?
T: Oh yeah, I find maths a struggle, not so much in class but usually when I get home, I can’t remember what, how I did it or, I try to do it again and again and never get that answer and give up.
I: What do you think could be done to help you, what could be done in the classroom to help?
T: More time, more work, but like homework based on what someone wants, someone struggling or something like me, if she gave a whole lot of sheets that score achieved questions, or like they might put in the exam, and you just keep doing those, keep doing those. If it is harder than achieved question I not going to get it. I think someone that you know they’re really good at it, and they should get excellence type homework, put people at different levels.

I: What about compared to something like English
Tara: Um like how friendly they are you mean? Um, well I think English and maths are definitely different in the styles they’re taught. Um, well again with English instead of learning like what it is, you learn ideas, I mean you make your ideas; you make your own decisions about them. So like you can learn about themes but you’re the one who has to decide what the theme is and in maths it’s not like that. You can learn about trigonometry and then you have trigonometry and that’s what you have but English its sort of getting the skills to make your own ideas about things. So um, the teaching styles different and um lets see. In English we um, the teaching like, um how we learn is the same, we’ll learn it, but what you get out of the learning is different.

Unlike many of the girls’ experiences in mathematics, Tara spoke about history and English with enthusiasm and excitement. Tara used three positive adjectives to describe history: love, like and enjoy. This is in contrast to the many girls who talk about mathematics
using negative adjectives such as hate and dislike. Some students believe that mathematics has been designed in such a way to be difficult and unenjoyable (Davidson, 2008). Key differences between these two subjects and mathematics appear to be related to the context and the learning process. Tara describes history as being about people and cultures, and English as based around themes. There are also differences in the teaching style with more interaction with the teacher in history as well as discussion. Tara found mathematics a struggle, particularly when it came to doing the work at home. She seemed to experience difficulties with being able to take the skills learnt in class and apply them to her homework tasks. She suggested that the teacher should give her homework at the level she can do, that is, differentiate between the needs of individuals in the class, providing work she would be capable of doing. This relates well to research that showed that students not only want to gain mathematical knowledge, but also be able to “participate more proficiently in mathematical practices” (Anthony & Walshaw, 2010, p. 4). For Tara she wanted to be able to complete her mathematics homework competently and confidently.

It appears that Tara feels that they are all treated the same in mathematics: one worksheet to cater for all. This contrasted with English where she suggested she learnt things but was able to decide which themes she wanted to focus on. Tara enjoyed being given opportunities to develop her own ideas in English. Encouraging students to think for themselves is termed a form of “subjectification” (Brantlinger, 2014, p. 207) and often results in more positive engagement. “Objectification” is more common in mathematics classes where student ideas are not appreciated or sometimes not even called upon and where students are treated as “empty vessels that need to be filled up with official knowledge’ (Brantlinger, 2014, p. 207). Tara’s comment, “you can learn about trigonometry and then you have trigonometry and that’s what you have,” reinforces this concept of objectification as it indicates that Tara may not have seen any personal attachment to the work in mathematics. Mathematics was just presented in a certain way and it could not be changed and Tara was to learn trigonometry because she was told to learn it.

For many of the girls in this research they did not experience anything exciting or engaging in their mathematics classrooms. For example, Amy described numbers and algebra using the words “not interesting”. This concept of mathematics as not interesting may also relate to the discussion in the last section of this chapter and in Chapters Six and Seven about mathematics not being of relevance to girls because there are no links between the mathematics and real life. I asked Amy about what had caused her lack of enjoyment of mathematics. Her responses were:
Amy: Um, I don’t know … maybe it’s just the fact that it’s all the same sort of routine everyday and it’s the same thing that you do and yeah.

I: Can you describe the routine to me?

A: Its sort of like oh she’ll teach you something and its related something else anyway and then we’d get out our maths books and we’d do that, work on the questions and, no, when you get to sixth form it all seems the same, all the work like algebra and stuff.

Amy describes the same common discourses about school mathematics as the previous girls, that is, mathematics is all about routines or rules. Mathematics classrooms operate in a ritualistic way and students learn to live by the routines and the systems of rules and controls. Boaler (2009) calls this the “drill and kill” (p. 29) method of teaching mathematics. She believes that this traditional method of teaching is unproductive and that it encourages “passive learning” (p. 35) which results in thinking not being required in class and at times not even allowed or encouraged.

Algebra gets a special mention in the context of mathematics being all the “same”. Amy also mentioned her teacher as an integral part of the classroom routine, the same routines as mentioned earlier. This controlled environment is consistent with Foucault’s (1977) ideas about institutionally regulated docile bodies. During mathematics instruction Foucault’s (1980) notion of power/knowledge is mostly bound up in the construction of the learning environment. Regulation, normalisation, and the production of knowledge can be read as forms of discipline in mathematics. This “determines who may act and speak, how, and for whom” (Lee & Taylor, 1996, p. 67). It is worthy of note that Amy may have felt regulated in mathematics through her positioning in the discourse of classroom routines and the physical and social spaces provided in mathematics.

Space is socially constructed but it also constructs social relations as it can restrict how different students access the space, that is, how they are positioned in the classroom space (Gordon et al., 2000). My observations in the classrooms suggest that the mathematics classrooms were also a ‘space’ controlled by the teacher and dependent on the arrangement of the furniture and resources.

I noted in my field notes that two of the mathematics classrooms were set up in the traditional format of desks in pairs, all facing the whiteboard at the front of the room. The other mathematics classroom had a slightly different arrangement but the desks were still placed so that the students gravitated towards sitting in pairs for the most part. There were more desks than students in these classes. There were between twenty-two to twenty-four students present during each visit to the classrooms. The students mainly sat in pairs spread
around the room. How space is organised can matter more than many people would acknowledge (Paechter, 2003), and who organises and controls the space and how it is used may result in power struggles, educational differentiation, and social reproduction (Massey, 1992; Shilling, 1991). The teacher may have control over the way the furniture is set out but may not have control over who sits where. This “regionalisation of classroom space” (Nespor, 1997, p. 125) was perhaps a way for the teacher to maintain control over the classroom space; however, this was not always what occurred. It appeared to me that the students were free to sit wherever they liked in the mathematics classes; however, these seating arrangements stayed the same from lesson to lesson. This may result in evolving power relations within the mathematics classroom.

During my observations I did not witness any groupwork other than students interacting with others directly in front or behind them and often this interaction was not mathematically-focused. The mathematics classroom in the pilot study contrasted with the other three classrooms because it always had at least twenty-six students in the classroom and often there were only one or two spare seats (due to absences). This classroom was smaller in size compared to the others. In this classroom all of the desks sat two girls and they were all facing the front of the classroom towards the whiteboard.

What was similar in all four mathematics classrooms was that the students stayed in their seats for the duration of each lesson and were told off if they moved from their designated seats. The mathematics classrooms were defined regions of space where only certain permissible behaviours were allowed (Nespor, 1997). Harriet’s discussion about drama and then mathematics shows some interesting contrasts in regards to how classroom space was used.

I: So tell me what it is about drama that sort of makes you feel good about it.
Harriet: Um, oh I like drama because usually I’m pretty hyper and so we just get up and do fun stuff. Um.
I: So the moving around is quite important is it?
H: Yep.
I: Don’t you move round in maths?
H: The problem is when we’re moving around in maths we’re probably doing something like measuring triangles outside which isn’t generally much fun anyway so. So what else do I like about drama um. I like how it’s a really friendly atmosphere and so everyone just gets along. And instead of having you know like seats we all just sit on the stage somewhere, wherever we want and um yea.
I: Do you think maths could be taught like that?
H: Um, I’m trying to imagine our maths class just sitting on the stage wherever they want. Yea I think you could make a friendlier environment maybe. I think maths is a difficult subject to teach anyway, because a lot of people struggle with it so. I think math teachers are very brave to want to teach it.

In Chapter Seven, I discuss in more detail how many of the girls describe their other school subjects as being more fun than mathematics. Harriet saw drama class as somewhere she experienced fun and related this to being able to move about the room. Some students feel that if they are comfortable in a classroom space then they will engage more with a subject (Angier & Povey, 1999). Harriet may have felt more comfortable in drama than in mathematics because she was able to deviate from the set task and be socially involved with her peers. Girls have been shown to drop out of studying mathematics when they perceive their classrooms as unattractive and/or uncomfortable and/or hostile (Gherasim, Butnaru & Mairean, 2013; Riegle-Crumb, Farkas & Muller, 2006). A consideration of the spaces offered in mathematics could make a difference to girls’ experiences in mathematics.

Interestingly, during the pilot study, the design teacher also emphasised this view of mathematics as being somewhere where you did not need to move out of your seat. This is a scenario Harriet experienced in mathematics and in fact, she emphasised that even when they do an activity outside of the mathematics classroom this still does not count as fun. Harriet’s descriptions above do not tell me the truths of what “maths is or is not” (Mendick, 2006. p. 17), however, she was clearly positioned in various ways through the practices that she experienced in these two classes. Doing practicals outside of the mathematics classroom did not improving her liking for that subject. Mendick (2006) discusses some interesting binaries that are reflected in Harriet’s words above. First is the fun/not fun binary, which may be seen as a positive versus negative discursive practice. If you are having fun it follows that you will have a much more positive emotional response to a subject. Having to sit at desks in mathematics contrasts to being able to move about in drama and this can be seen as an example of the oppressive/productive binary, where mathematics may make you feel like you are restricted and immobile. Organisation and regionalisation of classroom space is perceived as reinforcing the control teachers have over their students (Nespor, 1997; Shilling, 1991). In contrast, drama class allows you to be actively involved in the production of a final result, for example, a play, developed in conjunction with the cooperation of other classmates as well as the teacher. This also reflects the always/simultaneously binary, where we may perceive the mathematics classroom as always being the same, consistent learning environment but the drama class contrasts this by allowing for learning and fun to co-inhabit the same space.
simultaneously. Harriet acknowledged that teaching mathematics would be a difficult job. Her reason for this was that so many students struggle with mathematics. Mathematics as a hard and boring subject will be discussed further in Chapter Seven.

Harriet tried to imagine mathematics taught in a similar fashion to drama. At the time she appeared quite amused by even having to consider this as a possibility. What she did suggest was that it might make mathematics friendlier, which implied she did not perceive mathematics as a friendly subject to be in. Being silent and motionless are often particular qualities of mathematics classrooms and the arrangements of desks are strategic management techniques used so that teachers can carefully watch students and keep their attention (Nespor, 1997). I also wonder if mathematics not being friendly has some links to the concept of discussing work and engaging with others, an experience that was very apparent in the drama class for all of the students there but lacking in mathematics. Girls’ performance in mathematics has been linked to their need to learn in friendly classrooms where they are comfortable and supported by their peers, particularly their female friends (Riegle-Crumb, Farkas & Muller, 2006). Discussion, or lack of discussion, and group work in mathematics were mentioned by many of the girls and this will be discussed in the following section.

Discussion and Group Work

Opening up possibilities for students to be involved in critical and engaging discussions in classrooms is essential for students to be positioned so as to experience happiness (Smith, 2010) and enjoyment in mathematics (Brantlinger, 2014). This means that they are given opportunities to take the subject matter presented to them and construct their own meanings about it and how it is valuable and useful by building their own understandings through critical analysis. For many of the girls in this research, discussion and working with others made a big difference to their enjoyment of a school subject. I asked Joy to tell me why fabric was her favourite subject and she replied:

J: Um, it’s more active, you move around, and you’re pretty much doing a practical everyday, making clothes or a skirt or something.

In fabric technology, Joy appreciated the hands-on approach to the subject but like Harriet in drama, she enjoyed being able to move around the classroom. This contrasts with mathematics, where the students were expected to stay in their seats and not move around. In fabric technology, they could work standing, discuss their work with peers or with the teacher, and they could work co-operatively on the tasks being undertaken. Communication
with peers is an important part of the classroom learning experience (Shannon, 2004) but this was not encouraged in the mathematics classroom. The students were more like “detached observers” (Nespor, 1997, p. 122) in the mathematics classroom.

Joy stated that discussion was an important part of her English and fabric technology class and this added to her enjoyment and engagement with a subject. When I asked Joy if discussion was part of mathematics she replied, “Um, no, because maths teachers shouldn’t really discuss things, because they’re trying to teach problems and formulas anyway, so it’s mostly to do with numbers in maths, than discussions”. This is similar to Boaler’s (2009) “pseudo contexts” (p. 47) or the idea of “disembedded thought” (Boaler, 2009; Mendick, 2006; Willis, 1990) where there does not appear to be any connection between the ritualistic mathematics taught in classrooms and real life experience and where often the contexts of problems are so contrived that the students do not recognise them as real. Shardlow (2011) reiterates this when she discusses that the real problem with mathematics currently is that far too many students find it hard, uninteresting and disconnected from real life. The following quote from Boaler (2009) emphasises this point:

If young people are asked to work in silence and they are not asked to offer their own ideas and perspectives they often feel disempowered and disenfranchised, ultimately choosing to leave mathematics even when they have performed well. (p. 43)

This suggests that the power is taken away from the students in mathematics classrooms and the focus stays on getting work right and not discussing concepts. Mathematics becomes more about “paying careful attention - watching what the teacher did and then doing the same” (Boaler, 2009, p. 75). Boaler (2009) also suggests that girls, more than boys, prefer more context-bound tasks so if mathematics is perceived as disconnected then it follows that girls more than boys will be affected by this and thus be turned off mathematics. Some research shows girls prefer to work collaboratively more than competitively (Head, 1996) and my classroom observations and discussions with some of the girls like Helen reinforced this view.

I: Yeah, what’s English like?
Helen: English is like um, it’s very mixed in that sort of area because you have to have lots of notes for your novels and your short stories and everything so that you remember them at the end of the year, but, you’ve also got to have like interaction with the class for speeches and discussing themes and all that, like lots of discussions and arguments and you know debates about things and quite interesting actually. Pretty
interesting, and then there was the times when we were given boring worksheets to do and we didn’t do them (laugh).

I: So you like that discussion stuff?

H: I did, yeah, its quite interesting to hear what everyone else thought about the book because it was a very controversial book, I don’t know if you’ve read 1984?

I: Mmm, long time along.

H: Yeah (laugh), that book was really fun, I liked the book.

I: So the whole class discussed it with the teacher, or how does that work?

H: The teacher she’s done it so many times so she knows it inside out and we got a lot of things wrong in it that she would clarify and give us ideas.

I: What do you mean you got things wrong?

H: Oh its just like concepts about the book wrong because the first time you read it you got to read it quite a lot of times, and she obviously knew we hadn’t, and we’d say things like “oh this and that means that”, and she’d be like, “ah no it doesn’t” (laugh).

I: Were your interpretations wrong or?

H: Yeah, just off a little bit. But there’s another book with unanswered questions in it like were the big brother and real, actually exist or are they just made up and stuff like that. We discussed, oh its quite cool.

Helen enjoyed being able to discuss, argue and debate with her classmates in English. This interaction in English provided Helen with a positive experience. Helen’s use of descriptors such as “quite interesting”, “pretty interesting”, “quite cool” and “fun” can be seen as “code words” (Walshaw & Brown, 2012, p. 185) suggesting that Helen experienced positive emotions in English through her positioning in the practices of this class (Zan, Brown, Evans & Hannula, 2006). There is an interaction between Helen’s experiences of English and how she thinks about that experience. Students change their thinking based on their experience of the “plane upon which they find themselves” (Walshaw & Brown, 2012, p. 195). It appears that the whole class discussion and interaction around a set reading text allowed for Helen to critically analyse and think about the different themes. She appeared very engaged with the book and told me the book was fun. The opposite often happens in mathematics classes. Often the teaching is context-free and rarely do students discuss mathematics in relation to their own daily experiences (Lyle, 2000). Many students find it difficult to easily give examples of the use for their school mathematics outside of the school environment (Davidson, 2008). Mathematics is often perceived as mindless calculating and endless problems disconnected from real life events (Shardlow, 2011) providing little
opportunity for cognitive engagement and resulting in differentiated rates of participation (Walshaw & Brown, 2012).

I do find it interesting that even in English the teacher may be perceived as the “fount of all knowledge” (Klein, 2004, p. 44). Harriet gave a good example of this when she told me that the teacher had to correct their ideas in class, indicating that the students’ interpretations were wrong and that the teacher’s were right. This positions the teacher as maybe still holding the power in this English class but at the same time providing an enjoyable learning environment. However, unlike mathematics, there appears to be more opportunity to discuss the work in other subjects such as English.

Ngaire and Karen also discuss English in similar ways to Helen.

I: Tell me about English.
Ngaire: Yeah, probably my favourite subject
I: Yeah, why?
N: I don’t know, probably just the easiest, I like writing and I would do a lot anyway, so when you do it in English, and I like to read so.
I: OK and what, how does the teacher, what’s her teaching style?
N: Um, she likes discussion, in class there’s a lot of discussion
I: So what kind of things do you discuss in English?
N: Um, sometimes when others are trying to explain things, what they’re trying to express, um, we discuss like the different things in the videos or in books or poems, and yeah all that kind of thing, so that’s a good way to reinforce your learning, to understand it

I: So what do you do in English that might be different from maths?
Karen: It’s more, it’s writing and reading, it’s not anything to do with numbers, and it’s more creative as well.
I: Do you get to discuss stuff in maths?
K: No not really.
I: Do you get to discuss stuff in other subjects?
K: In English yeah. We discuss a lot in that, and history of art we did. English it would be like the books and stuff we’d read and the movies we’d watched. History of art in the end of the year we found we were just asking Miss [history of art teacher] questions and she just answered them for us, talked to us, which was good, like about old French art and stuff, So yeah, it was pretty good.

Ngaire said that English was her favourite subject and explained that there was a lot of discussion in English. She emphasised that the discussion and being able to listen to others’
ideas played an important role in helping her to understand the work. The discussion was also significant in reinforcing her learning. My reading of Ngaire’s transcript is that she enjoyed listening to other students’ ideas and found this helpful for consolidating her own cognitive processes. Karen appeared to enjoy discussion in English and history of art. An intriguing aspect of Karen’s interview was that she described English in a contrasting way to mathematics as “not anything to do with numbers” and “creative”. This is interesting as it reinforces the discourse of mathematics as being “all about numbers” (Davidson, 2008, p. 6) and not providing a creative space for many learners. It is as though Karen has come to understand how it is to be positioned in mathematics compared to English through the pedagogical practices she has experienced in both subjects. Her subjectivity has been constructed through discourses that are mapped out for her in everyday classroom procedures (Walshaw & Brown, 2012). Karen liked discussion and also liked her history of art teaching talking to the students. It seems that there was a freedom in this class for open questioning on aspects of the course content and the teacher allowed free engagement as a normal part of the class time. These relationships between students and teachers are often seen as the “essence of teaching and learning” (Ellwood, 2010, p. 47) as they aid in constituting a supportive and memorable learning environment that results in positive experiences. Karen told me that discussion in these classes “made it easier” for her to learn. I asked if she thought discussion might make it easier to learn mathematics and she replied:

Karen: I don’t know, because in Maths you sort of learn to do something a certain way and once you’ve got it actually imbedded in your head you’re fine with it.
I: What happens if it doesn’t get imbedded?
K: Then you lose it like I do.
I: And then what?
K: If you write it down you’re fine, and you can sort of recall it, but if you don’t you’re pretty much screwed unless you go to tutorials and have to learn it all again, which is pretty annoying

My interpretation of the above is that Karen feels that by being able to talk and discuss in her other subjects she is then able to retain knowledge. The social aspects allow her to think through the work in collaboration with others and this cognitive procedure helps her remember the work and the new ideas she is presented with. In contrast, Karen suggests that mathematics is learnt in a certain way; different to other subjects, and that it needs to be “embedded” in her head to keep it there for future use. The concept of embedding is difficult to unpack, but I wonder if it relates to a form of rote learning that is common in mathematics
or the concept of practice, practice, practice the same types of questions over and over again until you remember the process. Karen suggests that if she writes it down enough she will sometimes be able to “recall” the work but it appears that this is not always a successful mechanism and she indicates that she is “pretty much screwed”, that is, she would not have been able to do the work in an assessment task if this happened. The teacher may be positioned as the expert and students are expected to mimic the methods used in class. There is often too much emphasis on knowledge-transmission pedagogies controlled by the teacher so that students do not feel any attachment to the learning process (Witte, 1995). Transmission-type approaches to teaching mathematics are also very much removing mathematics from the girls’ everyday experiences, positioning mathematics as a transcendent, stable, and abstract discursive object (Renert & Davis, 2010).

When there is no discussion it communicates to Karen and the other girls that maybe their ideas do not count for anything in mathematics. Karen told me that mathematics was “a lot of individual work” and when I asked her to describe a typical lesson she responded:

Karen: Teacher yelling “sit down”, the notes at the start of the lesson, then an exercise on what you did. Pretty much that was most days. Yeah, you got into the routine of it, you got your routine, a bit boring after a while, you sort of despised it, but you did it anyway.

Once again, the pedagogical practices in mathematics are described in a similar vein to the other girls’ descriptions earlier and to my field notes. The recurrent discourses of routine and boring appear, but more disturbing is Karen’s use of the word “despised”. For me this is an even stronger word than boring and hate, expressing a powerful, emotive response to her experiences in mathematics. Karen was positioned in such a way that she despised what she was doing, but still did it because that was what was expected of her.

Traditional teaching methods where students sit at their desks working mostly alone and where they are not actively involved in the learning process close down any chance for student input and ideas (Brantlinger, 2014). Like the girls earlier, Tara told me that both English and history had “quite a lot of discussion” but when I asked her what happens in mathematics she replied: “Not usually discussion, no, not really, because it’s more textbook stuff, read it and do it. It’s more stressful in a way, hard”. The mathematical discourses that Tara was positioned in caused her to feel the emotion of stress and to experience mathematics as a difficult subject compared to her other subjects. The experience of “read it and do it” contrasts significantly with the discussion experience in other subjects. The quality of dialogue in a classroom is fundamental for student subjectification but it appears that mostly
the girls in this research were objectified by the teacher-centred discourses (Gutstein, 2003) they were positioned in while in mathematics classrooms. They were unable to express their own ideas in mathematics and were positioned as passive learners, unable to contribute to their own learning processes. It is no surprise then that these girls enjoyed their other school subjects more than mathematics.

Practicals and Practical Uses of School Mathematics

I was interested in asking the research girls about the practical aspects of their school mathematics and whether this resulted in transferrable skills that they could take from school to use in the future. The intention was to discuss how practical mathematics at school might prepare students for life after school. There are two parts to this: practical components of the course, that is, hands-on experience using mathematical tools, materials and equipment, and future practical uses for the mathematics learnt at school. When mathematics is taught without context it appears difficult for students to see the relevance of what they are learning.

Perhaps we do not listen carefully enough to girls who continue to tell us (such as teachers, parents, researchers) that school mathematics does not make any sense and that they cannot see the point of school mathematics. Maybe the “fault is in the mathematics, and not the teaching, not the learning, not the people” (Johnston, 1995, p. 226). Even though many would like to assume that mathematics is a field of knowledge that can help us to discover more about the world we live in, in schools mathematics “belies this truth and presents a formalized, ‘objective’, and discrete systems of skills and rules that is largely void of the context that gave rise to it” (Boaler & Sengupta-Irving, 2006, p. 215). Unfortunately, many students may learn knowledge that is not necessarily useful to them in their personal or future lives, and certainly not useful for solving their own mathematical problems (Witte, 1995).

With changes to curriculum development in mathematics in the 1990s and more recently in 2007, there is a belief that old styles/methods of teaching mathematics have disappeared from New Zealand schools and, that sitting alongside progressive teacher training, our mathematics teachers in schools are delivering mathematics programmes that engage all students in their classrooms. The use of context is implicit in the curriculum documents of 1992 and 2007. However, from the responses of my research girls it would be more correct to assume that mathematics at the senior secondary level is still taught in a traditional approach and largely driven by the need to address assessment needs attached to the NCEA framework. What follows here is a closer examination of the practical aspects that were part of their Year Twelve mathematics’ experience.
Practicals in mathematics

Nine of the girls in my research spoke about the practical aspects of their school mathematics. I classify a practical as any part of the course that was a hands-on activity using equipment. These practical experiences could happen in the classroom as contextual activities not related to normal note-taking or written exercises, or they could be an out of the classroom activity involving the solving of real-life problems. In the weeks leading up to my interviews the Level Two mathematics classes had all completed an achievement standard on trigonometry. When I questioned the girls about practical aspects of their mathematics classes they associated the concept of practical mathematics with this particular assessment task. As part of the task they used equipment such as clinometers, rulers, and tape measures to measure the height of the chimney on the school boiler room or a flagpole. The collection of the measurements was done in small groups of two or three students, but the reporting of the mathematical results was completed individually for a final assessment grade. Polly, Amy Ngaire, Vicki, and Leanne spoke to me about the trigonometry assessment. Polly’s comments arose as part of a conversation more specifically about her mathematics teacher and why she liked that teacher:

I: So does [maths teacher] do lots of practical stuff with you or hands on activities?

Polly: Not really. The only practical things we’ve done is using the clinometers and stuff which was last week where we had to go out and measure the height of a chimney.

I thought that Polly might have liked the teacher because she may have done more practical work in class, but Polly told me, when I asked her about other practical tasks such as measuring, that the only practical activity she had done all year in mathematics was the trigonometry practical. Polly’s recollection of her year in mathematics was that she had only used practical equipment for this one prescribed assessment task, which had assessment criteria requiring the students to take measurements to solve a trigonometric problem. Polly told me that the rest of the time the work had been on worksheets and from the textbook. This use of worksheets and textbooks is still very much a common practice in many New Zealand mathematics classrooms (Harvey & Averill, 2008).
Amy mentioned the trigonometry task also:

I: And what about um, do the teachers make [mathematics] relevant? Say they’re teaching you something like trigonometry, does it, can they, do they make it real life?

Amy: Um, well, with trigonometry yes, like you know, we had to go out and measure the height of the chimney and stuff.

I: So would you normally go out and measure the height of chimneys?

A: No (laugh).

At first Amy suggested that measuring the height of the chimney was a relevant real-life task but when I questioned her about whether she would actually ever do this she laughed, as she responded “no”. My feeling at that point was that she realised that the task was not a task that anyone would usually do. When I observed this class the teacher did not make any attempt to link the measuring of the chimney to the students’ out-of-school experiences. There was no blending of the trigonometric skills being taught with real-life understandings. It appeared that the assessment task was a stand-alone event. Much has been written (Boaler, 2009; Forbes, 1996; Mendick, 2003, 2005, 2006; Willis, 1990) about how mathematical tasks are often inauthentic or contrived to appear realistic. In fact, they do not relate to the experiences of most individuals. Rarely do teachers use students’ personal out-of-school experiences to make links between the concepts learnt in mathematics and there is an absence of social relevance in mathematics pedagogy (Brantlinger, 2014; Ensign, 1997). My interviews and observations showed that mathematics existed “independently of personal experience” (Ensign, 1997, p. 254) and was taught in a sequential, hierarchical way with a focus on doing problems not discussing problems. This hierarchy of mathematical learning and content helps to support the ideas of mathematics being more about right and wrong, and its authority as a subject that “demands respect and precludes everyday experiences” (Ensign, 1997, p. 256). The token value of the trigonometry task as part of their year of school mathematics does little to disestablish the idea of mathematics being about established knowledge and fixed frameworks. Higgins (1997) found that many students became quite cynical of school mathematics when they failed to see any real significance or value for it in their everyday lives.

When I asked Ngaire and Vicki how much practical work they did in mathematics they also responded with mention of the trigonometry assessment task:

I: How much hands on practical stuff do you do in Maths?
Ngaire: Not much at all, apart from like the trig assessment where we went out and measured the chimney but that’s pretty much it I think

I: So how much practical stuff do you do in maths?

Vicki: Not much. … Um with the statistics one you have to collect information and process it so I suppose that was a good idea and the trigonometry one you had to go out and measure the chimney up there and that was alright.

I: What about during the rest of the year did you have any practical things to do?

V: No.

Vicki mentioned collecting data for statistics as a practical experience. She called it the “statistics one” which I interpreted as the statistics assessment task because she immediately continued to speak about the “trigonometry one”, discussing the same assessment task as the other girls. This suggests that practicals might have only been a part of assessment tasks in their course. Vicki was the only girl to mention the statistics and I am not sure if that is because the others could not remember the task or whether they did not do the same task as Vicki. I asked Leanne specifically about the statistics task and she indicated that she had not done anything practical:

I: Are there many classes where you get to do sort of practical things?, I mean obviously your fabrics and food.

Leanne: Yeah (laugh)

I: But, what about some of the other subjects?

L: Um, well we do, occasionally do, um, like experiments in biology. … Leaves and microscopes and stuff.

I: Yep.

L: Um, and in maths we went out and measured like a chimney and something just like um, height of the flagpole and little funny dangly measure things, yeah.

I: Did you do any other practical stuff in maths?

L: Um.

I: Either in the classroom or out of the classroom?

L: Not really.

I: Nothing with statistics?

L: Not that I can remember.
Leanne remembered the trigonometry assessment, but was not able to give me any further examples of practicals done in her mathematics classes. She does practical, hands-on tasks in at least three of her other subjects and these were all subjects that Leanne told me she enjoyed more than mathematics. Boaler (2009) believes that girls prefer more context-bound tasks, but my earlier work (Shannon, 2004) accentuates that the context has to be relevant and realistic, not just contrived. The one-off practical trigonometry assessment task did not appear to impact on these girls’ negative experiences of school mathematics, that is, they saw it just as an assessment task and nothing more; it did not show them a real-life and relevant context for their mathematical understanding. Mendick’s (2003) research results emphasised that “the quest for understanding” (p. 174) can be frustrated by the procedural mathematics lesson. In mathematics classrooms many hours are filled by the students doing short, repetitive problems that involve mostly isolated procedures (Boaler, 2009). They rarely experience open-ended problems that require higher-level thinking skills and allow them to link ideas to their own lived experiences.

Students need to experience mathematics in such a way that they can see the links between the problems they are given in class and the world around them. When mathematics becomes distanced from human experience and real contexts it sets students, and perhaps girls in particular, up to fail to engage with the content on any level. Many girls want opportunities to query and investigate more deeply. They are often averse to experiences of mathematics that emphasise rote learning. The same may be true for many boys but the consequence of many girls being denied access to a meaningful experience in mathematics is that they are likely to be turned off the subject (Boaler, 2009) and may chose to do other more engaging school subjects instead.

Often students do not think that the teachers make mathematics relevant to them. In earlier work, Jane’s comment below reinforces this idea.

Jane: Like you make all these problems and give them real life situations … but I like really didn’t see … like, why do I need to know how fast or how far away he’s going to land if he’s jumping at this speed, or whatever, like basically as long as I can make it work I don’t mind (Jane, my emphasis). (Shannon, 2004, p. 511)

Although teachers may have tried to make mathematics relevant, the reality is that this may not help their interest levels or enjoyment of mathematics. Male oriented examples about cars, rockets, parachutes, and sports are often used to describe the motion of objects. By using “he’s” Jane was identifying the male oriented context of the mathematics she was doing in class. For most students there is a noticeable lack of discussion in classes about the usefulness
of the mathematics they do at school and how it can be applied to the real world. Often tasks are perceived as male-oriented or just easier for boys to engage with giving girls the view that mathematics is not relevant to their futures (see Boaler, 2009; Forgasz & Leder, 1996). Girls whether mathematically successful or not, often view mathematics as disconnected from their own experiences which adds to their dislike for the subject and discourages them from studying the subject at a higher level.

**Practical uses of mathematics**

Whether school mathematics provides practical and useful skills for students in the future is another area that the girls spoke about. I was interested in finding out if there were aspects of their course experiences that they thought they would carry through with them to help in their chosen future careers. Polly suggested some ideas:

I: Of the things that you have learnt in maths this year what do you think you will use in the future?
Polly: Umm I don’t actually know. Possibly, maybe fractions and statistics. And with like fractions you can do taxes or whatever. I don’t know.
I: What about some of the other things like calculus that you mentioned before?
P: Umm. I mean it would be good if you were going to one of those professions, which use that, but I’m not so, I don’t think I would be doing anything with them.

Polly mentioned fractions and statistics as areas of mathematics that she might use in the future. The only elaboration on this was her mention of taxes but her overall response appeared vague as the “I don’t know” statement emphasises. We had previously discussed calculus so I was interested to see if Polly saw any relationship between the content of calculus in Year Twelve and how she might use it in the future. Polly suggested that some “professions” might use it, however, she suggested that personally she would probably have no use for it. Polly’s use of the word “professions” is interesting as it could be classified as a reasonably old-fashioned term for a particular type of job such as, for example, a lawyer, an accountant, or maybe an engineer; jobs typically aligned to having particular academic/university training or higher status in our society. If Polly was indeed thinking about these types of jobs then she was subtly classifying calculus/mathematics as being associated with higher status jobs. It follows then, that when she suggested she would not use
calculus that she was positioning herself as someone who might not have a profession or high status position later.

Amy did not see school mathematics as useful for future life either. She spoke about mathematics as useful for certain degrees to begin with.

I: So how useful do you think it is?
Amy: Um, not very useful unless again you’re going to go into university and do a maths degree or something like that. … maybe science degree or something.

To begin with Amy states that school mathematics is only useful if you are going to do a “maths degree”, adding “science degree” as another thought. She uses the words “something” or “something like that” maybe realising that her answer does not cover all of the uses of mathematics at university but unable to give further detail as to specific careers or post-school experiences that might require the use of the mathematics she has been exposed to at school. It is of concern that Amy could not give any specific uses of school mathematics beyond the association with university study, that is, that after four years at secondary school did not see mathematics as leading anywhere other than the above options. I prompted Amy about whether mathematics could be used in everyday life to unpack this some more:

I: If the Year Twelve course had been more sort of useful or related more to everyday life, do you think that would have been better for you?
Amy: Yeah, definitely. Um, because then I could relate to what we are learning and stuff, cos like yeah.
I: So what's wrong with the course at the moment?
A: It’s no use doing all this work and like to me I don’t really understand like why are we going to need this because it just seems like I don’t know, because it’s just in maths books, but that’s all we’re doing it for, you know, worksheets that’s all it is really.
I: Does the teacher tell you what you’re going you use if for?
A: No, just basically.
I: Would that help?
A: Yeah I guess so, yeah, yeah it would. … because basically all we get told is oh we’re going to need it to get onto Year Thirteen maths, need to know it, but then, need, you need to know stuff to get into university or something.
I: Is there anything that you’ve done this year that’s useful in real life?
A: No (laugh), not in maths anyway.
Amy agreed that if mathematics had been more related to her everyday experiences it might have been more useful. She suggested that if it was more related to things she was interested in then she may have connected with it more personally. By saying, “then I could relate to what we are learning and stuff” suggests that she did not feel connected to the learning that she had experienced in mathematics at school. This may indicate a male interpretation of mathematics that produces a curriculum, which is often abstract in that contexts and concepts are for the most part presented as inaccessible to girls. When men define mathematics it becomes about absolutes and a reality not known to girls’ experiences and this absoluteness may have the effect of intimidation on their learning, as the mathematical world appears too abstract (Forgasz & Leder, 1996; Shadlow, 2011). Many girls may feel powerless in the presence of masculinised, de-contextualised, de-peopled mathematical ideas and perceive mathematics as only accessible to those who learn to follow the underpinning male rules of mathematics. Jane, in my earlier work (Shannon, 2004), also described mathematics as “irrelevant as she failed to see any context-relevance in the subject, that is, nothing of real-life interest to keep her connected and thinking” (p. 515).

Amy does not appear to see any links between what she does in her maths book, or on a maths worksheet, and her own needs. She says she does not understand why she needs that type of mathematics and what it is used for. Amy suggests that her teachers have not shown her the relationship between the textbook/worksheet tasks in class and how this relates to real-life. The experiences of girls can add to the value of a male interpreted mathematics that produces a theoretical curriculum devoid of context (Mendick, 2003). When I asked Amy if it would help knowing more about the mathematics she agreed that it would and implied that all the teachers ever tell her is that she needs it for the mathematics course the following year or for getting into university. The prerequisites, which are set for particular courses, determine a “knowledge hierarchy” (Kenway et al., 1998, pg. 73) for school subjects. The promotion of mathematics as a prerequisite for many courses disregards the fact that a substantial amount of the mathematics learnt at school has no relevance to the particular courses that require it. Many tertiary and career pathways which stipulate mathematics as an essential prerequisite do not actually use any of the mathematical concepts that they determine must be achieved prior to selection (Johnston, 1994). Amy’s comments suggest that this was not helpful information for her and I would propose that she did not see this use of mathematics as of intrinsic value to her engagement with the course. Amy went on to state that she had not done anything in mathematics that year that would help her in the future and in fact laughed when she suggested that mathematics might be the one subject where this had happened, implying that what she has learnt in other subjects will be useful in the future.
Joy and Leanne also agreed that school mathematics was not useful for real life and their futures:

I: Do you think any of its useful for real life?
Joy: If I thought about that, probably.
I: But not off the top of your head.
J: No (laugh)
I: Does that worry you?
J: No not really.

I: So do you think the maths you’re doing in class is going to be useful for you in the future?
Leanne: Ahhh, (laugh), I don’t know, it’s a good question, do you mean like this year?
I: Mmm, particularly this year.
L: Um, I don’t know.
I: Tell me about um how much of it you think you’ll use in your everyday life?
L: Probably not a lot.
I: Why do you think that is?
L: Well we were doing a thing today about um, I don’t what it was, but it was like little graphs and looked like waves and you know, I was wondering what would we use it for in sort of everyday life. … um, and Joy said “oh you know, if you want to find out how big waves are and stuff”, and I’m like yeah ok.

Joy did not seem too concerned about her mathematics not being relevant to her. Maybe she had become so used to how school mathematics was taught and how she experienced it that she was immune to the mathematical discourses she was positioned in. Both Joy and Leanne, like Amy, laughed when I asked them about the usefulness of school mathematics. I wrote in my notes that it was “like an instant almost ironical response to me even suggesting that mathematics could possibly ever be useful or real-life”. Leanne gave an example of graphs and how Joy had told her that they might relate to waves but I do not believe that Leanne was convinced about that connection. Joy also studied physics so she might have had more of an idea about the relationship between graphs and waves than Leanne did. On the tape Leanne said “yeah ok” in a sarcastic voice as in suggesting to Joy that she really did not believe what she was saying as a truth. Leanne appeared unconvinced that any of her school mathematics could be taken seriously as a useful tool for her future. In contrast, Vicki at first
appeared quite positive about the relevance of school mathematics to her life and future. However, on closer examination of her transcript there appear to be many contradictions:

### I: So how much of it is useful?
Vicki: Quite a lot of its useful now you know. Last year it wasn’t useful like it was really simple but like this year it sort of got in more interesting because you can apply it more to real things.

### I: Can you give me an example? Can you think of anything that comes to mind?
V: Um – I don’t know trigonometry like the trigonometry thing you do right angles and stuff like that for three years and then all of a sudden you have to learn all of these formulas and I mean trigonometry is just one of those things that really is applicable to daily life.

### I: And how often do you think you are going to use this?
V: Oh not really but you know you can get a job and it will you know will have to work with trigonometry if you do something like you know engineering or something like that.

Vicki suggests that mathematics in Year Twelve is more useful than in previous years. She seems to associate not useful with the mathematics being “simple” and goes on to imply that it did become more interesting when she saw the applications of it. I also wonder if Vicki subconsciously associated mathematics as being more useful if it was harder. When I asked for an example, Vicki, like many of the others, chose trigonometry as her evidence for usefulness. Where she appears to contradict herself is in that she speaks about trigonometry being about finding angles and so on leading up to Year Twelve and then says that “all of a sudden you have to learn all of these formulas” which when I listen to the tape she says in a way/tone that implies this was a bad thing. Straight after this though, she appears to justify the trigonometry as being important because it is “applicable to daily life”. Her transcript does not really tell us why she thinks trigonometry is applicable but my impression was that she is repeating a message she had heard in classroom discourse and was presenting it to me as a truth about trigonometry. I challenged her to think about where she was going to use trigonometry and once again I received a reply telling me it being useful for getting a job and specifically a job such as engineering. The same discourses appear in Vicki’s transcript as appeared in many of the other girls; discourses associated with usefulness being related to future employment but employment that is recognised as more for boys than for girls, also mixed messages about the way mathematics is presented as about formulas or rules and how this relates to perceptions of mathematics according to the binaries easy/hard or useful/not useful.
When I asked Lucy (in the pilot study) about applications or practical uses in mathematics she appeared confused by my question:

I: And what about when you get on to sort of applications and things? Do you like that part of maths?
Lucy: Um?
I: Word problems
L: Oh, sometimes but again I don’t like the ones where you have to do for graphs. Yeah, like the ones in our homework books.
I: And what did that ask you to do?
L: Not sure actually, but that was um, you had to put just a weird context, like um, building houses and stuff and then put a curve on it. But sometimes they word them quite weirdly.
I: Yep, did they seem real?
L: Um, not really, to me they’re things that I can’t imagine.

Lucy was more comfortable with the mention of word problems instead of applications, and said that sometimes she liked word problems. However, when she spoke about the graphing problems she used the words “weird context” to explain them. She was both suggesting that the context was weird and that the way the problems were worded was weird. These two ideas bring to the fore many of the common issues that the other girls have also mentioned. The idea of weird context is tied to other ideas about how many mathematics problems are written to try and simulate a real-life experience, but that often these girls did not see the connection at all and still found it difficult to engage with the problems. Lucy’s comment “they’re things that I can’t imagine” reiterates this strongly. Her lived reality is not associated with “building houses and stuff” and so it makes it very difficult for her to experience these problems with prior knowledge about the context. I would even propose that this setting once again shows how many contexts used are masculinised, suggesting that mathematics is a world for boys/men, although many boys at that age probably have few experiences of building sites also. The other issue that Lucy raised was about the word problems not being easy to understand. Boaler’s (2002, 2009, 2012) works suggest that this method of teaching is not accessible to many students and that when they meet unfamiliar contexts, they show minimal understanding of how to apply mathematics learnt at school.

Not being able to do or relate to the word problems may position many girls as not good at mathematics. The emotions associated with struggling with word problems may cause negative experiences and even a sense of pain (Mendick, 2006). It is perceived that mathematics is useful for everyday life, but Mendick (2006) found that when students were
asked to give tangible examples of this usefulness they were unable to. In this section I have shown that practical skills and practical applications need to be more visible in mathematics learning, however, any practical mathematics must be realistic and not artificial; it needs to link clearly to the real lives of all students so that they can clearly see its usefulness.

**Summary**

My research questions are ‘What are girls’ experiences of secondary school mathematics?’ and ‘How do girls’ experiences of mathematics compare and/or contrast with their experiences of their other school subjects?’ It has become clear in this chapter that the girls in this research have experienced a construction of school mathematics that positions them in variously different ways to how they are positioned in many of their other school subjects. Traditional pedagogies that involve teacher-directed classroom spaces dominate their experiences of mathematics. The mathematics learning environments were constructed in linear ways with each lesson resembling the lesson before or the lesson after, with the only difference being the skills being taught. There was very little opportunity for discussion and group work in mathematics. This contrasts considerably with their experiences in other subjects such as drama, food technology and English.

The girls were able to move freely around the rooms in other subjects, they were able to control their own learning progression by having freedom to construct their own knowledge production in collaboration with others by discussing their work with both the teacher and their peers. In contrast to mathematics, other subjects were described using positive adjectives such as fun, enjoyable and creative. Rarely in mathematics did the girls experience practical, hands-on activities, and rarely did they see any practical uses for the mathematical skills they were being taught. Realistic contexts were missing and they found it difficult to link mathematical ideas to real-world experiences. This chapter has examined various aspects of classroom pedagogy and has revealed that these girls viewed their other subjects as providing them with much more positive and enjoyable learning experiences. These negative experiences of mathematics influenced whether these girls chose to continue with mathematics in the future. The next chapter looks at the future usefulness of mathematics and examines reasons why girls feel they need to do or not do school mathematics or mathematics post-school even when they do not enjoy it.
CHAPTER SIX: USING SCHOOL MATHEMATICS

The girls in this research had complicated and multifaceted experiences of school mathematics and their other school subjects. Informed by the literature and the methodologies detailed in the previous chapters, Chapter Six discusses the girls’ views about the value and usefulness of mathematics. These findings emerged from analysing the girls’ responses from their interviews alongside field notes, visual data, and responses from their mathematics teachers and the school principal. This chapter also addresses the research question, “What are girls’ experiences of secondary school mathematics?” It discusses the girls’ views on why they chose to study/not study mathematics at school and how they see/do not see mathematics as useful for their individual futures. These binaries are quite simplistic and there appear to be cases where the students do not clearly fit the demarcated lines implied by these binaries. Instead they waver on the periphery, not easily positioned in the binary I have constructed above. This chapter discusses the value of mathematics ‘credits’ in terms of the neoliberal discourses that affect young people.

Future Discourses

My research girls appear to be well divided between those that saw no use of school mathematics for their futures, those that saw it as useful for gaining qualifications, and those that saw it as a gatekeeper for a particular career choice or job. The girls could be sorted into three subgroups: those who saw no future in mathematics because they were intending to head in the arts direction; those who did not know what their future held or who did but knew they just did not need mathematics; and those who understood that mathematics had a role to play in securing the ‘right’ options for their choices post-school. The following sections discuss how some of the participants did not see any need for mathematics in their arts courses, how many of the girls felt obliged to study mathematics, and how studying mathematics was viewed as a way of keeping future pathways open for longer. The discourse that follows has direct links to my research question where the girls’ experiences of school mathematics are examined from the viewpoint of how they made them feel about engaging with mathematics in the future.

“I Don’t Need Maths for Arts”

In this section I will use three girls’ stories to describe how they did not see any value in their school mathematics for their future careers in the arts. Vicki, Polly and Karen were
looking at careers that they considered did not need mathematics as a basis and because of this and their experiences of mathematics, they did not want to study mathematics in the future. These girls’ stories speak back to the research (Anthony & Walshaw, 2007; Ma, 2001) that says that mathematics is vital for a student’s success academically and in their chosen career.

When I asked Vicki what she was going to do when she left school she said she was going to study Political Studies. I asked her if she was going to need maths for that and she replied, “Probably not, maybe”. I asked her if she was going to do maths next year and once again she responded, “Probably not”. When I asked her to tell me about that decision she replied, “It’s just so hard, you know like I chose kind of easy subjects like history and stuff”7. In Vicki’s view, Political Studies does not require mathematics. She sees mathematics as too hard for her, so she has decided to opt out in her final year of mathematics so that she can study “easier” subjects such as history, history of art, classics, English and painting. For many students who struggle with skills such as essay writing, these subject choices would not be deemed as easy choices at all, but for Vicki, compared to mathematics, they are. When I prompted Vicki to think about whether she might need some knowledge of statistics for Political Studies, she agreed that she might, “Yes, I suppose you do need statistics don’t you?” She still appeared adamant that overall she did not need to do any more mathematics to pursue her chosen career path. Vicki told me she had considered the Statistics option as her mathematics course next year but when I asked her what influenced her final decision to not study any mathematics, she replied, “I just don’t need it”. Another interpretation here is could be that Vicki has chosen a career to avoid mathematics. She may not making a statement about the usefulness of mathematics, rather she may be making a statement about the relevance of mathematics for her career. She may actually consider mathematics to be a useful subject, but she is not going to be part of it because of her own relationship with the subject. This alternative reading is only subtly different but important. Even if she can see some usefulness in mathematics, her emotions/feelings about the difficulty of the subject/her anxiety make the idea of taking it abhorrent. She could be practising avoidance, using her agency to disengage from mathematics. It appears that Vicki is negotiating with herself and her need to avoid the negative feeling over any vague idea of mathematics being useful.

Vicki fits nicely into the group of students who in Wood et al.’s (2011) work saw no utility value of mathematics for their future. Also, like their research, Vicki gave brief answers to my questions such as “none...a small part...or a large part” (p. 110). This made it

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7 This concept of mathematics as being hard is a recurring theme in the data and I will look at this in more detail in the next chapter.
very difficult to quiz her in detail about her thoughts and reasons. I believe that if Vicki had acquired more information about political science and what a career in this field would require she might have seen the importance of mathematics. At this stage, Vicki had an idea in her mind about political science that separated it from needing mathematics as a required and valuable skill. The reality is that for a successful career in this area she would need a good mathematical understanding, especially in the manipulation of statistics.

Polly had similar views to Vicki, although Polly had decided she was going to do mathematics at school the following year.

I: So why are doing maths [next year]?
Polly: Because I’ve found it easy to do in the past so it’s a subject I can pass and I don’t mind doing it and it’s good for your qualifications. That’s what the people expect you to do and I don’t do science so.

I: So you said it’s what the people expect you to do. What do you mean by that?
P: Oh like umm because like because like when you go to university you need certain things. They expect to see a science or a maths written down there or for student qualifications you have that and stuff.

Polly’s responses above capture the complexity of the issue of a student choosing whether to do or not do mathematics. Because of her past experiences, Polly saw mathematics as a subject that she was capable of continuing with the following year. She also did not mind doing the subject. Her reasons for doing mathematics appear to be about having a final result of mathematics as a qualification on her results transcript as expected by others which she terms “they”. We are not told who “they” are specifically but we could assume “they” are her teachers or maybe her parents and perhaps those who will decide her fate regarding entry into university at a later stage. It could also mean societal expectations and ideals or the educational/employment institutions as a whole. Just as in the work of Sadker and Sadker (1995) and Murray (2011), Vicki and Polly are not clear in their responses about why they have to do mathematics but it comes across that they have learnt a truth that they do have to do mathematics at school. Ingram (2011), in her longitudinal research, which tracked students from Year Ten to Year Twelve, found that students were aware of the importance of choosing mathematics and succeeding in mathematics. She writes that this view of mathematics is often a reflection of the families’ views and the views of others in their community; students knew mathematics was needed in the future because their teachers, parents and school had told them so. However they were unconvinced of this because they did not identify the skills they
were learning in class as being directly useful to them personally. This discourse about having to do mathematics appears in some of the other girls’ responses also as will be shown later.

Polly sees mathematics as easy, in contrast to many others, and as a good way of gaining credits on the qualification framework. She also believes that mathematics (and science) results give you prestige in the eyes of the university people who will view her results. There does not appear to be any intrinsic enjoyment of mathematics, just a need to have a qualification with mathematics. Another missing aspect from Polly’s interview was that she never once suggested that there was a link between mathematics and it being useful for life-long learning. Sullivan and McDonough (2007) suggest that student motivation is closely aligned to how students link their current experiences at school with their perceived future aspirations. This implies that if girls such as Polly do not see any connection between school mathematics and their future, then they will not be motivated to continue to persevere with it. In fact, none of the girls in my research mentioned any core value of mathematics as part of their everyday social life and functioning in the future. Studying mathematics appeared to be directly linked to future courses, not future daily life. Polly interpreted her own learning possibilities and life opportunities in relation to her view of mathematics as not useful to her future. Skovsmose (2005) would see that this “foreground” (p. 7) of Polly interpreting her own learning possibilities and life opportunities in relation to her view of mathematics as not useful to her future, as influencing her engagement with mathematics and her resistance towards continuing with mathematics in the future. This view is supported by the following excerpt, where Polly points out that she will not continue with mathematics after she leaves school, mathematics appears to be simply a means to an end for Polly.

I: Do you think you will do maths at university?
Polly: No [laugh]
I: That was a very quick no.
P: I mean I’m good and stuff but I just wouldn’t do it.
I: Can you explain why?
P: Just because I don’t want to.
I: OK. You don’t need it for...
P: No, not for the drama stuff. Because I’m more likely to go to an arts school so they don’t do maths there. Yea

Polly wants to study drama at university and believes there would be no need for mathematics at Art School. Both Vicki and Polly agree that their choices of art courses will not require any mathematics. I am not sure where they gained this opinion and it would have
been interesting to interrogate their perceived ideas about no mathematics in the arts. Ingram (2011) also found that some of the students in her research felt that they did not need to continue with mathematics through to year thirteen especially one girl who wanted a career in fashion design or music, subjects aligned to the arts. Other girls in my research group reinforced this view in their interviews. Karen stated that she would probably not use any of the mathematics she had learnt at school that year, a perception that Johnston (1994) found in her research. Often the mathematics learnt at school appears to have very little resemblance or links to girls’ experiences of the real world and the future careers they desire. When I asked Karen how she felt about not being able to use her school mathematics she replied:

Karen:  Bad. Ohh, I’m getting, I’m probably going to get myself into a line of work that has nothing to do with that sort of stuff, so.

I:  What do you want to do?

K:  Probably art, I want to sort of maybe open a gallery or work in a gallery. …

K:  It won’t really involve that much Maths, only the basics.

Karen identifies that the possible mathematics in a career in a gallery would be basic mathematics implying that this is not the mathematics she has been taught in Year Twelve. Murray (2011) showed that many students saw senior mathematics as irrelevant, having no real value to them personally. Karen, like Vicki and Polly, did not see any use for mathematics in the arts. This relates to the work of Forgasz and Leder (1996, 2010) who showed that students did not experience discussions at school about the usefulness of mathematics to their everyday lives and their future career choices. This is an interesting tension. They did not experience these discussions yet there is an implicit expectation that students should not only do mathematics, but they should do well in it too. Research has shown that young people looked back on their schooling and wished that they had known more about the importance of mathematics; there was a feeling of regret that maybe if they had known more about the importance of mathematics post-school they might have taken school mathematics more seriously (Forgasz & Leder, 1996, 2010). Karen, Vicki and Polly saw the personal “utility value” (Watt, 2006) of their school mathematics as very low and because of this, they became part of the filtering process where many girls disengage from mathematics in the senior years of their schooling (see Shapka et al., 2006). Jane, in my earlier research (Shannon, 2004), was also part of this pipeline leading away from mathematics. She decided that mathematics had no utility value for her and her future career, and even though she had tremendous ability mathematically, she opted out to study the arts
subjects that she enjoyed more. These girls having chosen a path into the arts have decided that mathematics (or at the very least, the type of mathematics they have experienced at school) is irrelevant to their future and have joined the flow of girls exiting on the mathematics pipeline.

“\textit{I felt obliged to do it}”

In contrast to the girls in the previous section, there are still some girls who continue to study mathematics. Often they continue to study it in spite of poor experiences and reticent feelings about its usefulness because they perceive that they \textit{have to} keep doing school mathematics. Seven of the girls studied fitted into the category of those who felt that they \textit{had} to do mathematics at school. Sarah told me she was not going to study mathematics the next year. I asked her if there was anything that might change this and she replied, “It might if I figured out what I’m going to do”, emphasising that mathematics is only necessary for specific paths and that if she chose a path that might need mathematics then she may reconsider. Sarah, like many of the other girls, experienced the tension of knowing that mathematics might be required for some future pathways. Based on her past experiences of school mathematics, however, she was reluctant to consider continuing with it unless she really had to. Amy had already decided that she did not want to go to university. Mathematics was superfluous to her needs.

\begin{quote}
Amy: I think for ever, since I came to High School, I haven’t really enjoyed [mathematics].
I: O.k. But you keep [doing mathematics], you’ve done it this year. Is there a reason why you continued with it?
A: Um, for it will be useful I guess, get into like University or whatever.
\ldots
A: But I’m not going to University, anymore, so.
I: So what does that mean as far as Maths goes?
A: Well I’m definitely dropping it next year.
\end{quote}

Amy had studied mathematics in Year Twelve because she thought she might need the credits to get into her university of choice. Now that she had decided university was no longer an option she did not see any reason for continuing with it. Interestingly, Amy did not see opting out of mathematics as a barrier to her future.
I: So thinking about you know, across your subjects we’re focussing on Maths at this stage, you know the things that you learn in Maths, are they going to be useful for your future?

Amy: I, well I don’t think they will but, um, like the teachers and staff say that they will be.

I: What do they say?

A: Oh they say, “oh you’ll need this”, and I think the only reason that would be useful would be to get into University or something. …

A: Just as a qualification, unless you want to take like Statistics Course. … Yeah.

I: Yeah, so do you think you’re going to need that Maths later on?

A: No.

I: O.k., the things you’re looking at doing you don’t think you’re going to need Maths?

A: No.

I: Do you think its, because you’re not going to do Maths next year do you think its going to stop you from being able to choose some things?

A: Ummm, no.

One reading of this is that Amy only perceived mathematics as useful for university and because she had decided not to pursue that path she could not see any other relevance for studying school mathematics. Another reading is that Amy was influenced by the perceived instructions of her teachers to study mathematics and she chose to do the opposite. This may be an example of her using her agency to defy what others told her was good for her future.

Harriet had decided during the year that she wanted to go to polytechnic to study nursing. She regretted taking mathematics that year because she now realised that she needed biology for the nursing course and was going to have to take level three biology the following year and try to catch up the biology content she had missed in Year Twelve. Harriet told me that she already had the mathematics credits she needed to be accepted into nursing and was disappointed that she had wasted the year doing mathematics when she did not need it for her future. She told me that “looking back I’m not sure I would take it if I hadn’t thought it was compulsory”.

Like many of the other girls, Harriet only saw mathematics as useful for getting into her choice of course. Not once did she mention any usefulness of the mathematics she had learnt at school for her future. Joy reiterated this view when she stated that she would probably use none of the mathematics she had learnt at school. She said, “I would’ve forgotten it by then anyway”, suggesting that the mathematics she had learnt had not been retained as knowledge she could carry with her through to the next year and to her future life. When I asked Joy if
she was going to do mathematics the following year, she indicated that she would have to redo the course she was presently in as she had already failed Year Twelve mathematics and how “I would’ve hated [Year Thirteen] maths”. I asked her why and she replied, “Because I can’t do [Year Twelve] maths, so”. She later went on to discuss mathematics and some of her other subjects.

Joy: It was a cool subject in [Years Nine, Ten and Eleven], and I was sort of obliged to do it in [Year Twelve]. …

I: Can you tell me why you felt obliged?

J: Because I did it all those other years, maybe because my Dad’s a technician, ahh felt like I should do maths, and because it’s easier than physics, so.

Joy suggests above that she continued with mathematics because of the influence of her father. Fathers’ expectations have been shown to be a significant factor for girls’ feelings about mathematics and mathematics course taking in the recent work of You and Sharkey (2012). Joy enjoyed her other subjects more as will be discussed further in Chapter Seven. What surprised me in the discussion with Joy was that even though she did not enjoy mathematics, she was not going to opt out the following year. She was going to repeat the course she had in her view already failed. She felt she had already failed because she had not passed any internal assessments and she did not believe she would pass any of the upcoming external assessments either. Joy said she felt “obliged” and that she “should do maths” in the above excerpt. One interpretation of the use of the words *obliged* and *should* is that she had no agency in her decision to continue with mathematics the following year. She seems to think that she has to take mathematics, that is, that it is one of the only available subject positions made available to her through the available discourses. This available discourse could be about always doing mathematics at school, year after year, as on a continuum. Joy thinks she wants to take this line of action because she believes it is expected of her by her father and maybe her teachers. This could be an example of what Davies (1991) called a “forced choice” as discussed in the Agency section of Chapter Two. It is a forced choice because, for Joy, she sees no other option than to take mathematics the following year. The effect of this “forced choice” may be that Joy studies mathematics when she would prefer to study another subject that she enjoys more such as fabric technology.

When I asked Tara how much school mathematics she might use when she leaves school, she answered, “Maths, probably none, I mean I’m not planning on [being] an engineer or anything where I have to work with co-ordinates and algebra and graphs”. Tara appeared to
view school mathematics in terms of specific topics and could not see the relevance of these aspects of mathematics for her future. She associated mathematics with the work of an engineer. This is interesting as it shows how she has learnt that these are the types of careers that one would associate with studying mathematics. This emphasises an important aspect of school mathematics, which is that people disassociate mathematics with real life experience and everyday life. Paechter (2000) calls this “decontextualized knowledge” (p. 27), which is knowledge that is seen to be “pure”, or of “higher status”, marking it as the masculine domain and constructed to exclude many groups including women. Tara’s memory of mathematics as being about co-ordinates, algebra, and graphs shows how the content of Year Twelve school mathematics in particular is not relevant to practical aspects of her life. These topics are abstract and often taught in a way that shows no links to any real world experiences. For example, students learn algebra by completing worksheet after worksheet of repetitive type problems, an activity not connected to any aspect of real life mathematics. Paechter (2000) classifies this as a “hegemonic curriculum” (p. 23) and writes how this places mathematics on the academic or masculine side of the binary academic/practical.

Decisions about both what is taught and what is not are taken within gendered power/knowledge relations; they reflect the levels and types of power accorded to different forms of knowledge and different actors in the decision-making process. (Paechter, 2000, p. 29)

This positions aspects of mathematics such as algebra as being more important or powerful than other areas that may not be taught at all or taught with less rigour. An example of this is where in some schools courses perceived as more academic include algebra and calculus achievement standards. The alternative courses, perceived as less academic and for less-able students, may not have any algebra or calculus content. Topics such as networks or simulation are substituted for the algebra and calculus. This may result in students in these alternative courses being positioned as a different type of mathematics’ learner; often a learner with lesser ability and less access to some future courses and careers.

Mathematics is seen as a powerful area of knowledge. Foucault (1978) discusses how we can gain pleasure from the power that is often associated with being able to do scientific/mathematical/academic things. It then follows that if girls cannot engage with these aspects of the mathematics curriculum then they do not gain this feeling of pleasure or “human connectedness” (Paechter, 2000, p. 29) that is linked to female ways of thinking. Girls/women are more likely to take account of the context in a variety of settings and may feel that to engage means denying their own subjectivity or self, which may mean a denial of their femininity (Kenway & Youdell, 2011; Mendick, 2006). Girls may not want to be in
mathematics or be the best in mathematics as this goes against conventional notions of femininity such as “sharing, caring, and essentially “fitting in”” (Francis, 2010b, p. 31, original emphasis).

Helen appeared to have had regained her self at school by repositioning herself within mathematical discourses. Helen was not studying mathematics when I interviewed her. She had been accelerated in Year Ten and so by the time she reached Year Twelve, she had opted out of mathematics. She studied Year Twelve mathematics while she was in Year Eleven, but she had an unsuccessful experience of mathematics as an accelerated student. Her positioning within mathematical discourses altered during her time at secondary school where she was the able, accelerated mathematics student, then the struggling mathematics student, and now, the detached mathematics student. Helen’s transcript drew upon many discourses to articulate her perceptions of mathematics, her subjectivity within mathematics over time, and how these related to her future. Even though Helen opted out of mathematics, there is this sense that she still felt some obligation to be studying mathematics.

Helen had discussed with her mother the option of getting a tutor for mathematics if she needed to catch-up any of the level two credits she had missed out on the previous year. Helen preferred this idea of a tutor to joining in with a school mathematics class. My field notes record that Helen was a little embarrassed about turning out to be a ‘failure’ in mathematics after having been selected as an extension student earlier in her schooling. I felt, during her interview, that she continually felt the need to explain that, if she needed more mathematics credits for her future, she would somehow make that happen.

Helen: Mum said that I could probably do [more mathematics credits], I wouldn’t take any Maths classes, I’d get a tutor... and learn how to do those two really well so that I’d pass, pass them and hopefully pass Level Two and just get my Certificate or that, so I can say I’ve done it.

I: Ok, so you’re looking at um, the fact that you need a certain number of Maths credits for Level Two.

H: Yeah, just be nice to, like I don’t know what kind of job I want yet, so I’m just thinking that it would be able to say that I did pass Level Two [mathematics], with a bit of a struggle but I passed it.

Helen described to me how she had stopped doing drama this year because she felt that history of art was more academic. Helen did not express the same sadness for having opted out of mathematics. We discussed her subject selections, which was heavily ‘arts’ loaded with the exception of biology (although biology is more associated with being a girls’ subject than
the other sciences so is often positioned on the arts side of the art/science binary see ref). Helen gave the impression that studying arts might not be a lucrative pathway for her future.

I: Ok, [be]cause you’ve got quite a you know a focus on kind of Arts subjects haven’t you.

H: I know, that’s what scares me (laugh), I don’t want to be an Artist. …

H: [Be]cause I don’t generally get any money [un]til I die.

Helen may have had concerns about her subjects and how they would be useful for her in finding a suitable and well-paid career. There is often a perception that careers with a focus on science and mathematics are the better paid jobs where STEM careers are male dominated and males in STEM jobs have greater earning potential than females (see Riegle-Crumb & King, 2010).

Helen felt that she could add in some more Level Two mathematics credits if she needed them. She appeared to be more focussed on the value of the credits than on the mathematics she might learn. She could see the potential that mathematics would give her in the quest to leave as many future options available as possible.

I: And, and if you’ve got that [extra maths credits], do you think perhaps that would leave some doors open?

H: Yeah hopefully. …

H: I just don’t want to leave school without feeling like I’ve done everything to get the best grades, ‘cause Level One’s all very fine and nice, but if you’ve got Level Two, even though I didn’t do any of that in the past year now, at least its, then it might give a better impression of.

I: So this is where um, this system works quite well, because you can just pick out a couple that you want.

H: I hope I’ve been, I’ve been I can, by a few, I’ve been told I can’t by a few but I’ll see, I’ve got a good reputation at school so they might let me away with it.

Helen was hoping that her past reputation for being a capable student in mathematics might allow her to just sit a couple of extra mathematics papers so that she could add the credits that she felt she might need to secure better options career-wise in the future. Helen was still considering the option of level three mathematics in year thirteen, but knew she did not have enough algebra credits as prerequisites at the time of the interview. I asked her what made algebra so special and she could only reply in terms of the credit value saying, “Oh that’s what you’ve got to get to move on … 5 algebra credits”. I was expecting a response in
terms of the algebra content that would be needed to engage successfully with the course content in level three but Helen reiterated the, by now, common discourse around the credit value of mathematics topics and no mention of any skills and knowledge came forth. What follows below is an excerpt from Helen’s transcript about how useful mathematics was to her. As she listed the topics in mathematics such as algebra, trigonometry, and calculus, she was trying to think of how they might be used but was unable to articulate any ideas to me at all. She suggested that her teachers had not told her about any contexts for these mathematics topics and I suggest some reasons for this. One interpretation could be that the teachers did not know any useful contexts. Secondly, that they just felt there was not enough time to discuss the mathematics in any detail beyond the regular classroom routines. A third interpretation may be that they did actually discuss it, but Helen did not pick up on it or did not remember it. She compares mathematics to classics and describes how she felt that her mathematics teacher could not teach like her classics teacher because of the time constraints brought on by the assessment system in mathematics.

I: So what kind of Maths was useful?
H: (Sigh), well, um, I don’t know, um, I don’t know, yeah, maybe graphs was useful for other subjects like. …
H: Science, we’ve used a few graphs in Bio this year, but apart from that I will never go out number sequencing, just scraped past it, um, Algebra I’ve not come any use for it yet. …
H: And Trig, I don’t know, when do you really use trig in any of our life, I don’t know (laugh), and I can’t remember Calculus. Is that useful for anything?
I: I don’t know (laugh), mmm.
H: I’ve no idea.
I: So when your teachers were teaching you some of these subjects did they tell you about some of the things that they could be used for?
H: Um I vaguely remember [maths teacher] liked to tell jokes, I can remember that about the bee (laugh), but um, no they didn’t say anything about what its used for, [classics teacher] spent the whole period sort of telling us um getting good marks in school is all very fine and dandy and all that sort of stuff, but in the long run, its really, when you go, when are you going to need about Olympia on the rock, and you’re like, and she’d always go on tangents sort of, telling us about like other free thought stuff to go, stuff like this. …
H: Which we actually might use when we’re older. …
H: She’d considered that probably important or more important than stuff we’re learning from the curriculum, and sort of like …
I: …Enquiring.
H: Yeah.
I: So um, did you feel in Maths they couldn’t do that, they couldn’t sort of go off on tangents?
H: No, ‘cause there wasn’t enough time to start off with, we were always like keep going and going. …
H: “You’re behind the other class, keep going, keep going”
I: Is this what the teacher said?
H: Yep.

Helen seemed aware that her classics teacher was able to go “on tangents” and realised that learning in classics was about thinking beyond the curriculum. In contrast, she felt pressured to keep working at a particular pace in mathematics as directed by the teacher and the burden of keeping up with the work and the assessment regime that controlled her mathematical learning.

Leanne’s responses show some similarities to the other girls, but her discussion about fabric and food technology introduces some other considerations. During her interview Leanne told me she wanted to do maths the following year, but she was not sure that she would get enough credits to be allowed to study it. When prompted about her reasons for wanting to continue with maths, she indicated that she had to because she had not left herself many other options. Her statement, “I don’t really have many subjects left to do”, was related to her present subject combination and how she perceived this would affect her future choices of subjects. I questioned her about why this subject combination would restrict her the following year. She stated that it did not look like geography would be available as only three or four students had chosen geography and they needed about 12 to run the class. It was clear from her interview that she was very aware of the academic status of some subjects over others. This can be seen in the following excerpts:

Leanne: I want to do geography but probably not, and so I can’t do that I’ll have to have to another sort of academic [subject] rather than foods and fabrics so probably history.
I: Can you not do food and fabrics in Year 13?
L: Yeah I can, its just sort of, not really very academic sort of, like. …
I: Mmm, so, are you doing maths because you really like it, or are you doing it to, because its, its one of the subjects available?
L: Um, well I think I should as well.
I: Why do you think that?
L: If, well if I want to go onto university or at least I think it’s good to have sort of maths and English even though we don’t have to do them.
… And probably also because [maths is] a subject filler as such. … Yeah.

I: So why do you think it’s good to have maths and English?
L: I don’t know, sort of academic I suppose. I don’t know, um, to sort of like compared to all the arts. It’s sort of fine if you want to go to Arts school, or anything like that, but um, I don’t know, just sort of like you know, yeah, I can’t explain it, like you know English and maths all the way through kind of thing.

I: Mmm hmm, has anyone told you, you should be doing those two?
L: No.
I: Or is it just a feeling you have?
L: Yeah, like I don’t really want to be here next year, but I feel I should [be]cause I know I’ll regret it if I don’t.

There are multiple readings or interpretations of Leanne’s transcript. The first relates to Leanne’s use of the word ‘academic’. This can be read to reflect her perception that there is a hierarchy of school subjects as related to their academic capital for transfer to the university sector, post-school. Kenway et al. (1998) acknowledge in their writing that tertiary institutions have long held the power to determine which school subjects are and are not important and that subjects such as mathematics are used to determine your academic potential in the tertiary market. There is fierce competition for many places in tertiary courses and often subjects such as mathematics are used as prerequisites for selection into these sought after courses. For girls looking at these courses it becomes incredibly important that they choose mathematics at school and achieve good results (Johnston, 1994).

The prerequisites, which are set for particular courses, determine a “knowledge hierarchy” (Kenway et al., 1998, p. 73) for school subjects. The promotion of mathematics as a prerequisite for many courses disregards the fact that a substantial amount of the mathematics learnt at school has no relevance to the particular courses that require it. “Many pathways which specify mathematics as a prerequisite do not draw directly on mathematical concepts which are used as the selection device” (Johnston, 1994, p. 245). In spite of this, mathematics continues to be valued as more important than many other school subjects. Mathematics is often constructed as a ‘hard subject’ and this construction is closely connected with ideas about what boys/men can do (and what girls/woman cannot do). The hardness of mathematics is closely linked to notions of masculinity. This “reinforces what many students already know, that those subject areas most associated with the masculine are to be valued over those most associated with feminine” (Kenway et al., 1998, p. 73). This belief has persisted for many decades now as first discussed in the seminal work of Sue Willis (1990,
1991) and according to this research not much has changed in recent times to remedy this viewpoint.

It is the carefully fostered belief that all people who can do competitive forms of mathematics are more intelligent than all those who cannot, together with the practices associated with this view, which should be the focus of those who wish to assist girls and others who are excluded from many occupations in the name of mathematics. In my view, mathematics is too good to be used for such dishonest ends. (Willis, 1989, p. 36)

Mathematics is used as a selection tool. Its role for many in the tertiary sector is to specifically indicate a student’s general academic ability. A broad education is promoted for students at school, but as long as mathematics is used to control entry to further pathways this subject will remain dominant in considerations about subject choice. Many girls, through opting out, will continue to be pigeonholed into a mediocre selection of career opportunities.

Another reading of Leanne’s interview is her identifying mathematics alone on top of the academic hierarchy of subjects; Leanne included it with English, geography and history. Leanne felt that if she did not get enough credits for mathematics then she would choose history the following year, not fabric or food technology. It would seem that Leanne did not make a distinction based on a binary between feminine and masculine subjects, but rather on academic versus non-academic subjects.

Leanne seemed to have accepted the position of mathematics as a pivotal subject for the future by highlighting the significance of English and mathematics for her future as well as the importance of finishing high school. This belief that mathematics is a key subject for the future has been noticed by many other researchers (Campbell, 1995; Campbell & Campbell-Kibler, 2001; Johnston, 1994; Ma & Johnson, 2008; Wiest, 2011; Willis, 1990). On the other hand, Leanne also suggests that the fabric and food subjects are at the other end of the spectrum, identifying their lack of usefulness for her future. She even suggested during her interview that she had made some bad choices earlier on in her schooling. “Because I didn’t choose wisely when I was younger… so I’m sort of stuck with foods and fabrics sort of thing”. In her interview she spoke about enjoying these two subjects, but continued to focus on how they were not good choices for her future even though she was unsure of what she wanted to do after leaving school.

Leanne had accepted a school discourse that she needed to do English and mathematics “all the way through” school, but appeared unable to clearly articulate why she needed to do this. She felt these subjects were needed for university even though she was unclear about whether she would go to university. She appeared to not really want to be at school the
following year, but was worried that she might “regret it” if she did not return. She had a perception of what she should do at school but was concerned that this was a mismatch with the school subjects that she was studying at the time. She seemed to believe that she had wasted her time doing food and fabric technology because the credits gained in these subjects cannot be used for the entry requirements to university and that she was finding it difficult to reconcile this in her mind.

Her classification of subjects, such as English, mathematics and geography, as academic gave them value in her eyes. Food and fabric technology were not considered academic and did not have the necessary “social and economic power” (Mendick, 2003, p. 177) required to access the world of university. O’Neill’s (2004) description of technology classes as being the domain of working class students sets up another binary distinction, this time that of technology as working class versus academic subjects as middle class. The academic classification of the three subjects, English, mathematics and geography, implies that they are perceived as the province of the middle class. McKenzie (1992) indicates that working class has been associated with low intellect, a life of manual labour, and being a follower, not a leader. This then suggests that by studying academic subjects someone is perceived as being intellectual, a leader and interested in less practical related employment. Perhaps, Leanne had already decided that the academic road ahead was more desirable than the working class model implied by studying technology subjects.

“I want to keep options open”

For some girls continuing with mathematics was more about keeping doors open than about an intrinsic enjoyment of the subject. Lucy (from the pilot study) was a good example this type of student. She described herself as “odd” because she liked mathematics. I asked why enjoying mathematics would be seen as odd and she replied, “I don’t know, other people like things like history or design and things, I like maths personally”. When I asked her what she liked she then said, “well some things about it seem pointless to me” which seemed to contrast with her previous comment that she liked mathematics. I asked her what aspects of her mathematics seemed pointless.

Lucy: Um like some things like, I mean equations and stuff, and some things like trigonometry, and oh, trigonometry could sort of be helpful in some places I suppose.
I: Like where?
L: Ah, maybe design or architecture stuff like that. …
L: Um, but then something like the equations and algebra and stuff, it all seems pointless. …
L: Teachers don’t seem to put in, sort of, to the real world.

It was as though Lucy saw a perceived usefulness for studying mathematics, but this was at odds with her emotions about mathematics. Lucy introduced some interesting binaries as she discussed mathematics with me such as like/dislike, odd/normal, relevant/pointless, helpful/unusable, and real/realistic. Lucy used the words like, odd, pointless, helpful and real. Lucy appeared to transition from one side of the binary to the other depending on how she was positioned in the mathematical discourse she experienced at school. I asked Lucy if she could do the mathematics and she agreed but went on to say that she just did not see the point of things like equations in algebra. I then asked her how she might use the algebra to which she replied, “Unless you want to be like a maths teacher” followed by laughter. This is a common view that I have experienced in my own teaching where students believe that teachers are the only people who ever use algebra.

This pattern of conversation continued for quite a while where Lucy would tell me she liked trigonometry or geometry or statistics, but follow this by saying “though it’s just a bit pointless”. The two recurring words that Lucy used, that require further unpacking, are “like” and “pointless”. I speculate that “like” relates to being able to do the work because she told me, “I don’t really like graphs”, and followed this by telling me about how she could not do the recently introduced parabolas work in class. “Pointless” seems to convey ideas surrounding school mathematics as not having any real-life applications or context. Even though Lucy could do most of the work in mathematics, she did not see it as connected to anything tangible. This concept of mathematics as completely separate from the students’ real world has been discussed by Boaler in her work in the schools Amber Hill and Phoenix Park in the United Kingdom, and four schools in the United States (Boaler, 1997a, 2005, 2009). Povey (2010) summarises some of Boaler’s work and shows that the students taught mathematics via an open approach at Phoenix Hill were able to see how their school mathematical knowledge could be transferred through to real world situations giving them the confidence that they were equipped to take on broader contextual mathematical problems out of school. Lucy’s interview raises the question of how prepared is Lucy mathematically to take on the real world mathematics that she will encounter in her future? I questioned Lucy about what career ideas she had for when she leaves school:
L: I don’t know, I just wanted to be sort of a designer, but ... now I’ve got more important ideas like business ... and like maybe even psychology, but I don’t think I’ve done the right things at school to be a psychologist.

I: What kind of things do you think you might need to be a psychologist?

L: Um, probably more sciences cos I’ve only done one science, biology.

I: And what about, what sort of business area were you thinking?

L: Um, kind of like law, business law

Lucy told me she had looked at the university information book about design courses and it was not what she had expected. She aspired to go to university and the type of design work she was most interested in was not taught via a university course. This had got her thinking about other options such as the business law and psychology. It appeared that she was more interested in pursuing general university study, rather than perhaps looking at design at an alternative institution. It seemed that Lucy distinguished university study as higher in hierarchical status than alternative course providers such as a polytechnic. This may also reflect the difference in school culture between the two schools. Lucy’s school focussed more on academic pathways whereas the other research school provided a choice of both academic and vocational pathways for its students. I discussed this distinction some more in my analysis of Leanne’s comments earlier in this chapter.

Lucy was also worried about whether she had done the “right” subjects at school for psychology and mentioned science, but did not mention mathematics as a prerequisite to any of the career options that she spoke about. Lucy indicated to me that she would study mathematics the following year and implied that all of the girls at her school would do mathematics. I noted in my field notes that Lucy seemed somewhat bewildered that I might suggest that it was a choice to opt out. There may be many reasons for this such as Lucy’s school did not have as many different subject selections for year thirteen as in the research school and so by not continuing with mathematics students such as Lucy would be caught short on subject options. Another reason may be that for the girls in Lucy’s single-sex school, mathematics was just deemed to be one of those subjects (like English) that every student did no matter whether they liked it or not. This is another example of forced choices (Davies, 1991), but different to the other girls because the discourses Lucy was embedded in seemed different in a single-sex school to the co-educational school. There appeared to be more of an expectation that the girls would do mathematics in Year Twelve and thirteen in the single-sex school. The consequences of this may or may not have been beneficial, only over time can the effects be monitored as they choose and access certain career paths, but nevertheless,
someone has influenced their agentic selves by saying you must do mathematics. Lucy may end up loathing mathematics because she was made to do it or she may just accept that she is institutionalised or discursively positioned at this school by the discourse that the majority of girls do continue with mathematics and they accept it in the same way that they accept that they have to wear a uniform, stand when a teacher enters a room or attend chapel services.

Ngaiire was one of the few girls in my larger research group who told me she was going to continue to study mathematics the following year:

I: And, what, are you going to do Maths next year?
Ngaiire: (intake of breath) um yeah, probably, yeah I think so
I: One or both?
N: Ah just one
I: Which one?
N: Um probably Calc
I: Mmm hmm, what’s your reasons for that?
N: Um, don’t know, I like Calculus, of all the things I’ve done this year I’m assuming the algebra background thing is the way to go
I: And you can do Algebra?
N: Yep

Ngaiire was a little different to most of the other girls in my research group in that she only had two subjects which matched my ‘arts’ subject list: music and English. Ngaiire suggested in her interview that she had considered the idea of going to medical school and her other subjects included biology, chemistry, and physics. This combination of sciences with mathematics and English is considered the prerequisite school requirements to maximise entry into most health science courses at university. Ngaiire suggested that most people would not remember anything other than the basics in mathematics. I asked her why we do mathematics if this is the case. She responded, “they give you all sorts of reasons ... it’s good for your brain to do all this kind of thing, um, it stretches, it stretches your brain to do things, um, you’re probably doing it if you’re going into like medicine or anything like that”. Like Polly, Ngaiire uses the term ‘they’ to talk about the view of others. I interpret her use of ‘they’ as being her teachers.

Ngaiire told me that she had wanted to go to medical school for quite a long time, but was not sure if she would now. It was still a possibility and Ngaiire believed she had left her options open to reconsider medical school again because of her subject choices.
I: So why are you doing it [mathematics]?
N: Um, mostly because I don’t know what I want to do when I finish school so I wanna keep options open and if you do Maths and Science then you can sort of do whatever you want.
I: So you think its gonna sorta help you have open doors later?
N: Yeah
I: Yeah, so have no idea what you want to do?
N: No not really, no, I wanted to go to Medical School for quite a long time, yeah, I don’t know what I want to do now, I’m not sure
I: Is that not an option now?
N: It is still is, but I just don’t think I want to

Where Ngaire differed from many of the other girls was in that she had chosen subjects such as mathematics and sciences that she considered gave her more options for the future. She perceived that she had left multiple pathways available to herself by her careful and considered choice of subjects in Year Twelve and was going to continue with these going into her final year of schooling. Her choice of music was considered by her to be her extra subject, studied for enjoyment rather than for its future usefulness. Interestingly, when I asked Ngaire which subject was her favourite at school that year she responded with English. Other school subjects will be examined further in Chapter Seven.

**Credit Accumulation**

A recurring theme in the transcripts of the research girls is the notion of school mathematics being closely associated with the accumulation of credits under the NCEA qualification framework. Most of the girls were acutely aware that they needed to attain numeracy credits for the NCEA certificate and that these fourteen credits could come from Level One mathematics. These same fourteen credits were the minimum requirement for entry to university in New Zealand. Helen, Harriet, and Sarah specifically mentioned these fourteen credits:

Helen: Because I only need 14 credits or class credits or something, don’t know.

Harriet: Um, for university entrance all you need is 14 credits at level 1
Sarah: I don’t know, I’m more likely to do Stats than Calculus, and I don’t know, I’ve already got my credits in Maths for the University entrance, and I don’t know why, maybe.
I: Just the 14 that you need?
S: Yeah, the 14 that I’ve earned.

This suggests that they had been well informed about this requirement in their time at school. Other girls mentioned credits in relation to being able to partake in the next level of mathematics or in terms of numbers of credits needed for specific entry to tertiary courses:

Vicki: I don’t know if I’ll get the credits to pass maths yea. Because you need quite a few and you need to get calculus and stuff like that to actually get in and I’m not very good with calculus.
I: What made Algebra so special?
Helen: Oh that’s what you’ve got to get to move on.
I: Oh ok.
H: 5 in those credits.
I: To go to Level Three?
I: Yeah

I: Ok and then you’re going to apply for nursing next year to do the following year.
Harriet: Yep.
I: And have you had a look at what you need for that?
H: Yea, you need 14 credits in either biology or chemistry.
I: At any level or?
H: No level 3 and just to have 48, you need to have passes level 3 with 48 level 3 credits.

The discourse surrounding credits is a phenomenon closely related to NCEA. Prior to the introduction to NCEA, students talked about passing as the formal qualifications were for the most part examined by an end of year written examination and passing was considering gaining more than 50%. NCEA operates on a system of achievement standards, each standard worth a set number of credits. For example, in Year Twelve an algebra achievement standard might be worth 5 credits. The achievement standards are graded either not achieved, achieved, merit, or excellence with the latter three all being worth the same number of credits. The
achievement standards can be assessed internally by the teachers in the school and externally moderated, or externally assessed and marked. Unfortunately, anecdotal evidence suggests that the external assessments may still hold more value mostly because it is assumed there is no school bias in the marking. Both students and parents, at the school I work at, place more value on results in external assessments than internal assessments.

Thomas and Klymchuk (2012) have shown that there is a focus on credits at school and that some teachers focus on teaching to pass the assessments rather than teaching for learning. One teacher in their research discussed how the students only want to learn something if it is going to be in an assessment, they only value the end result or the credits. This same teacher viewed their students as rarely having a long-term view of the value the learning of the mathematics, that is, they had only short-term goals closely tied to each assessment task and passing. This has implications for the skills of “deeper thinking” (p. 298), especially if students only aim for a pass as higher thinking and reasoning skills only appear in the sections of the assessment tasks at the merit/excellence level. If students only want to be taught to pass and get the credits in mathematics then there is a fear that some teachers may only teach skills to enable that to happen.

I felt that in my research, the girls did not have a huge focus on results in terms of success and excellence, but more in terms of credit gathering to access future tertiary study. Not one of the girls mentioned leaving school and finding a job, they all had plans for future study. This closely reflects the recent work of Nairn, Higgins and Sligo (2012), who write an in-depth account of a group of New Zealand young people who they called the “Children of Rogernomics”. This work discusses the impact of neoliberal policies on the education and future aspirations of young people born in the years after 1984. These neoliberal discourses impacted on young people’s lives in many ways but most interesting for my research are the links with access to university and training opportunities which resonate in the experiences of my research girls.

Nairn et al. (2012) found that very few of their participants thought they could leave school and access employment. School education was not seen as sufficient to secure the types of jobs that the participants thought they would like to do as a career. They, like the girls in my research, believed that a “university qualification was a passport to, and almost a guarantee of, a good job that would pay well” (p. 41). The push to attend university came from many significant others in their lives including teachers and parents. Getting a job was expected to follow from getting a qualification. My research girls talked a lot about areas for further study, but not often about specific careers. For example, Ngaire discussed medicine, Lucy was interested in business law, and Harriet was more specific in wanting to be a nurse.
Others were much more vague; Karen, Vicki and Polly all expressed an interest in the arts, but did not discuss exact career paths. An implication of this may be that if they do choose to do a course later that requires mathematics they may be excluded because they did not continue to study mathematics at school or post-school.

The focus of my research was on school mathematics and so I felt the need to consider how neoliberal discourses have come into the mix with school mathematics and what this might mean for teachers of mathematics. None of the research girls made mention of considering a university course or career directly related to mathematics. For some of them, they saw the value of school mathematics qualifications for opening-doors to specific career paths, but did not directly value the intrinsic value of studying mathematics for its own sake. For the majority of my research girls, mathematics was just about getting the credits needed for gaining their NCEA qualification or for university entrance. The focus was on the end-result, not on the learning of mathematics. These girls valued education per se but they did not value mathematics.

Llewellyn and Mendick (2011) have written about neoliberalism and its relationship with quality and equity in mathematics. Neoliberalism positions the individual as being entirely self-responsible, adaptable, independent, self-managing, and able to reinvent themselves to be successful (Jackson, Paechter & Renold, 2010). They believe that neoliberalism as a “global policiespeak” (p. 50) has worked to enlarge the territory of markets and private enterprise and that this has major effects on education throughout the world. In the way that they worry about the emphasis on students progressing at school by what ever means, I am concerned about the emphasis on school and school mathematics becoming a tool for gaining access to university (or similar) and nothing more. “Teachers are positioned as marketers and children as customers/consumers within economistic discourse” (Llewellyn & Mendick, 2011, p. 53). This may have changed the positioning of teachers from the person who passes on the mathematical knowledge to students to the person who needs to justify the importance of the mathematics content and courses. The focus has turned to producing students with the required assessment criteria and away from a focus on life-long learning and personal development and accomplishment.

What does this mean for the girls in my study? Within these neoliberal discourses the individual student is not acknowledged, but becomes a production of structures within mathematics classrooms. The result is that the focus is on the quantity of credits earned in mathematics rather than the quality of the mathematical experience, as seen in the transcripts of Harriet, Helen and Vicki. For my research girls, mathematics is not an enjoyable experience anyhow (to be discussed further in the next chapter), but for the focus to move
away from learning to the gaining of credits more and more as they more through each level of school mathematics seems detrimental for their overall experience of mathematics.

This raises questions about whether we should be teaching mathematics in its current form and what the alternatives might be. This is particularly important given that mathematics is implicated in the neoliberal agenda of economic well-being, prosperity and competitiveness in a high skills global economy. (Llwewllyn & Mendick, 2011, p. 61)

Or maybe more importantly here in New Zealand, we need to raise questions about the effect of the NCEA regime on the teaching of mathematics. If the level of numeracy needed for access to university was raised to proficiency at level three would more girls (and boys) continue to study mathematics at school? What would happen if mathematics were compulsory at all levels? The mismatch between school mathematics and real mathematics is apparent and I discuss this in the next section. Is this mismatch driven by the types of assessment tasks used at school, and teachers feeling pressured to teach to the task instead of teaching for learning? (See Hagan, 2005). If in neoliberal discourses, mathematics is seen as a powerful tool for survival in the workplace, then girls opting out of mathematics are being disadvantaged in that they cannot take their place in the positions of authority in many powerful organisations that contribute to the decision-making and economic growth of the communities they must live in.

Summary

The girls discussed in this chapter have many ideas about the usefulness of school mathematics. These ideas are based on their experiences at school and their positioning as mathematics students. Their expectations of mathematics and their reasons for studying mathematics are bounded by many discourses around usefulness and future value for them personally and vocationally. There appears to be many tensions between learning mathematics because it is sold to them as something that is useful, but then finding that most of what they experience emerges as lacking in perceived usefulness for their futures. This chapter has focussed on the girls’ experiences of mathematics and how this affects their future choices and options. The next chapter examines their experiences in more detail with a particular focus on how these experiences are compared and contrasted with their other school subjects. The emotions of the girls, how they express their feelings about mathematics, will be examined.
CHAPTER SEVEN: RE-CONSTITUTING SCHOOL MATHEMATICS

This chapter provides additional insights into the girls’ emotions about mathematics. It looks at their descriptions of school mathematics and how this may impact on their disengagement from mathematics and their choosing to do/not do mathematics in the future. It draws on their experiences within the spaces of mathematics classrooms and covers the discourses surrounding mathematics as hard and/or boring and the emotions associated with doing school mathematics. The previous two chapters discussed the girls’ perceptions of mathematics teaching and their view of the usefulness of the subject; the consequences of which may result in the emotions and feelings expressed by the girls in this chapter.

“It’s just boring and hard”

An important part of how girls experience school mathematics is related to their feelings and emotions about the subject (see Ingram, 2011; Shannon, 2004; Zan, Brown Evans & Hannula, 2006). All of the girls in my study were positioned within mathematical discourses where their voices could be heard expressing affective notions such as maths is boring, hard or unengaging (see Davidson, 2008; Nardi & Steward, 2003). Often their view of mathematics was unenthusiastic and in stark contrast to their view of their other school subjects, suggesting that the school discourses they were positioned in altered from subject to subject. The binaries of hard/easy and boring/interesting or boring/exciting provide some interesting links to the hegemonic construction of mathematics as a gendered discourse (Chapman, 2001; Davies, 1996). These discourses are complicated and constantly weave in and out and around and about each other so any discussion in a linear fashion proves difficult. This section looks at the data from five of the research girls, how they described mathematics as hard and/or boring and attempts to unpack why they felt this way and what it is about the construction of school mathematics that may position the m in such a way.

I chose Amy to discuss first because she did not find mathematics enjoyable and she clearly and succinctly articulated the discourse of mathematics as boring and hard as reasons for that lack of enjoyment; a discourse that many of the other girls reiterated in this study.

I: So, how’s Maths for you?
Amy: Oh.
I: Is it an enjoyable subject?
A: No.
I: Ok, well tell me, can you elaborate on that?
A: Ah, it’s just boring and hard.
I: Ok.
A: I don’t really understand most of the things we do and stuff
I: Ok, what, what makes it boring?
A: Just like all these numbers, its just a lot of like, e squared plus something and something and not interesting.
I: Ok, and hard, is it hard as well?
A: Ah, probably it’s just because I don’t understand it, yeah.

Amy’s transcript above describes two of the common discourses about school mathematics; mathematics is boring and mathematics is hard. The prevailing discourses are “maths as hard, maths as currency in the labour market, and maths as boring and irrelevant” (Mendick, 2003, p. 171). These are powerful discourses because they may position some girls on the other more feminine side of the binary if they do not like or engage with mathematics at school; they may see other subjects as soft subjects or easy subjects or they might see other subjects as accessible affording them the status of being more fun and more exciting to be in. When I asked Amy what made mathematics ‘boring’ she spoke about mathematics being about numbers, interestingly using an algebra concept “e squared plus something and something” to strengthen her point. Numbers, algebra and calculus are the most common aspects of mathematics discussed by other participants. The mathematical discourses influence an individual’s educational choices and experiences in mathematics. “Hard is a relational term existing in binary opposition to easy, soft, and yielding, an opposition that parallels the associated one of masculine to feminine” (Mendick, 2003, p. 180, original emphasis). Amy also appears to associate the hardness of mathematics with her own lack of understanding. Twice in this extract she says, “I don’t understand,” the use of “I” suggesting that she interprets this situation as being her fault not the fault of the mathematics. This interpretation or attribution amongst girls in mathematics may make them feel that they are not capable of doing mathematics. This point has been emphasised by Ahlquist (2001) who argues, “we need to eliminate the anxieties that some young women feel because of misconceptions about who is and is not capable of learning higher level mathematics” (Ahlquist, 2001, p. 30). A lot of the blame for the ‘girl problem’ in mathematics has fallen on the girls themselves but many believe that it is the system that needs to change not the girls (Boaler, 1997b; Francis, 2010a; Walkerdine, 1998).
Other girls mentioned the word hard or harder (in italics) when discussing mathematics.

I: So tell me about NCEA and about Year 12 maths. How does Year 12 maths compare to last year?

Vicki: Well it’s a lot harder. Because you have to do the whole new calculus thing and there’s a whole lot of stuff that’s introduced this year that they didn’t do last year and fifth form is sort of like fourth form and third form as well. It all adds up to that, it makes it and you’ve done the work and it’s build up quite slowly to that but with sixth form it’s a big jump and you have to work harder and you know there’s a lot more stuff introduced. Yea.

Vicki: And its sort of a real sort of subject that you can do and you know to learn a whole new lot of stuff is kind of hard to have to memorise a whole lot.

Vicki’s interpretations seem to be at odds with those of Amy. Vicki uses the word harder to describe how Year Twelve mathematics compares to her earlier experiences. She acknowledges that in the previous year most of the content in mathematics was similar to work learnt the previous two years. She describes how the slower build up over the previous three year period suited her as it “all adds up” which implies that the content and skills may have been taught in a progressive way in small steps that suited her style of learning. The “big jump” from Year Eleven to Year Twelve is a common discourse often linked to the larger quantity of algebra that students suddenly become exposed to in Year Twelve (which I will discuss further on). The transcript above also indicates that Vicki is concerned about the need to accumulate masses of content knowledge which has become too difficult for her to remember “off by heart”. Vicki also indicates that she has to “work harder” and that there is a lot more volume of content introduced in Year Twelve. Unpacking the idea of having to work harder relates to the work of Smith (2010) where she examines aspects of “happiness through work” (p. 101).

Smith (2010) suggests that the concept of managing work, or in Vicki’s case, working harder, can be seen as a “synonym for learning, as an output and as a process” (p. 101). What this implies is that as Vicki adjusts to the new mathematics in Year Twelve she may have had to alter her subjectivity and make a choice as to whether to remain a passive learner in class or work “beyond what [she] enjoys” (p. 102). Vicki recognises that the content had become more difficult and adjusts to this situation by expressing the need to work harder to cope with this situation. The perceived ‘moving of the ground’ in Year Twelve mathematics has resulted in Vicki having to reposition herself as someone who now has to work harder to achieve her goals of success.
Interestingly, in Vicki’s last statement above she relays some other common discourses about school mathematics, that is, mathematics as a ‘real’ sort of subject and mathematics as a subject that involves memorisation or learning ‘off by heart’. The word real can be interpreted in many ways such as actual, physical, material, factual, tangible, valid, true, exact, genuine and authentic. If we look at the binary oppositions to these words we can come up with things such as unreal, imaginary, artificial, fake, pretend, imitation, and unnatural. Dissecting this further unravels some interesting ideas about how as mathematics gets ‘harder’ it becomes more significant due to it being perceived as more what mathematics should really be like. It almost implies that harder means more important or that previous mathematics was not ‘real’ mathematics but a quasi mathematics for those students who have not made it into Year Twelve mathematics which is when the real work of mathematics starts. The idea that memorization is part of Year Twelve mathematics links to this also, inferring that doing harder mathematics involves retaining facts. If memorizing or learning facts is perceived as doing true or valid mathematics then the implication is that to be a ‘real’ mathematics student one has to position oneself as someone who can take on this harder mathematics and learn in a particular way to achieve. Vicki may have an instrumental knowledge of mathematics, that is, it is all about procedures rather than a relational understanding. Even though Vicki succeeded in the previous three years with the slower build-up of the content she clearly sees that to be powerful in mathematics in Year Twelve requires a repositioning of her self to the ‘real’ work of ‘real mathematics’.

In regards to there being “more stuff” to learn, this may suggest an increase in the overall workload however, I also think that the ‘jump’ to Year Twelve as I indicated earlier may have a direct link to the algebra content. Joy indicated this in her discussion of mathematics below:

I: What’s different about Maths this year compared to last year?
Joy: It’s just harder.
I: What parts of the Maths is harder?
J: Um, parts I still couldn’t do last year, I still can’t do this year.
I: What are they?
J: Algebra, yeah, and introducing new topics like Calculus and yeah.
I: What makes Algebra hard?
J: I don’t know, I just can’t do it. Its impossible, it’s worse.
I: Did, did you feel like you were rushed during the year, to get through the work?
J: Sort of, but, not really, because the teacher just moved on anyway, so.
In Joy’s interview I specifically asked her about what parts of mathematics were harder. The two most common threads appeared in her reply, algebra and calculus. My question about ‘parts of maths’ was an attempt to draw out a discussion about mathematics in general, however, Joy was quite specific in her response that these two topics were the issue for her and her perception of Year Twelve mathematics as being harder. Polly also regarded Year Twelve mathematics as harder than previously however, in her discussion she focussed on the graphs topic rather than algebra specifically.

I: So can you tell me about Year 12 maths? How has it been?

Polly: It’s been OK, it’s definitely harder that last year. I mean I found most of the stuff pretty simple to do, like my, I’m pretty OK with most of the things except I’m just not that good at graphs just moving around and stuff. Yea, but other than that it’s pretty easy.

I: What makes it easy?

P: I don’t know. I’ve just been able to do maths so. Not really studying anything, cause I don’t do much study but I just can do it, I understand it.

I find this interesting because both graphs and calculus are very algebra-heavy topics, so although the girls separate the topics out in their conversations, there is clearly a link between what is hard in mathematics and how much algebra is involved. It does beg the question though whether the girls themselves identify graphs and calculus as being algebra or whether they have compartmentalised their mathematics course into discrete bite-size topics because of how mathematics is taught according to the standard being assessed at a particular point in time.

Although Polly indicates that the mathematics has got harder for her, unlike many of the other girls, she says for the most part it is ‘easy’. She suggests that she does not have to work hard and that she understands the work without having to put a whole lot of effort in. She does not mention that she enjoys mathematics but just that it is easy for her. What Polly does say though is that “I can just do it, I understand it” showing an association in her mind between the doing of mathematical work and the understanding. It would have been interesting to examine this in more detail with Polly because in contrast much of the research in this area indicates that often there is not a clear link between ‘doing’ and ‘understanding’ and that often girls feel disconnected from mathematics because even though they can ‘do’ the skill-based work they too often do not see the links to practical real-life understandings of
mathematics, that is, it is not real to them (see Chapter Six). The unpacking of the word ‘understanding’ may have provided more useful insights into what Polly was saying to me.

Helen, who was accelerated in Year Ten, had different reasons for finding mathematics ‘hard’ in the Year Twelve course. She was working a level ahead in mathematics for two years and this situation clearly impacted on how she experienced Year Twelve mathematics in a negative way.

Helen: I just catch up, everything I had to do was catching up, um, and stuff. I didn’t know any spelling or grammar or anything, so I’d been doing that up until this Maths, and so, I’m sort of used to it, and then Fifth Form came around and I was doing Sixth Form Maths, and it was really hard because I had to work on the other stuff as well, I just couldn’t work on Maths, so I ended up failing, I got seven credits I think, because I gave up about half way through the year...because I couldn’t do it, and I just didn’t, I didn’t even study for the exam.

I: So you were doing, when you got to Fifth Form you were doing um how many subjects all together?

H: Six maybe.

I: And one of them was Level Two Maths.

H: Yeah it was really hard, especially for me.

Helen was studying Year Twelve mathematics at the same time as doing all her other subjects at the Year Eleven/NCEA Level One stage. When she did Level One mathematics as an accelerated Year Ten subject her only formal assessment workload was in mathematics and so she coped with mathematics well. However, she struggled to balance the requirements of her Level One subjects alongside the workload and difficulty in the Level Two mathematics course, which as students have earlier indicated, was a big ‘jump-up’ in difficulty and workload. Helen only achieved seven Level Two mathematics credits out of a possible 20-24 available in that course. What was ‘hard’ for her was the balancing act of working at subjects at different curriculum levels. It appears that Helen made a ‘choice’ to give-up on her Level Two mathematics rather than sacrifice her learning and achievement in her other subjects. Smith (2010) writes, “not all clever students want to continue mathematics and not all those who struggle give up” (p. 100). Helen had been identified as a ‘clever’ student as shown by her being accelerated in Year Ten, however, she chose at the end of Year Eleven after ‘failing’ Level Two mathematics, to opt out of any future mathematical studies. Her use of the word ‘hard’ above relates to how studying six subjects including Level Two mathematics was too difficult for Helen but by saying “especially for me” she is suggesting that others may not have felt the same and that maybe she stood out as someone who just
could not cope with this situation. She constructs herself in this way as a ‘failure’ alongside how others coped in comparison to her, taking up a position as someone who did not belong in mathematics through failure to put in the required effort to change her results by not studying for the external examinations. Helen stated, “because I couldn’t do it, and I just didn’t” which indicates that she may have felt trapped by her situation. She gave up trying because she could not cope with the workload and level of the work but by saying “I just didn’t” indicates that maybe if she had tried she could have improved her lot. The “just didn’t” implies that maybe she could have turned things around by working harder but she used her own agency and chose not to. Individual agency and the contexts in which students find themselves may position them as powerless to act in ways contrary to their emotions and feelings (Mendick, 2006; Smith, 2010). The next extract shows many of the competing discourses that impacted on her feelings and emotions about mathematics and her subsequent decisions.

Helen: Um, um, I don’t know, well Maths was my most hated subject and Drama was probably like most loved subject, so that’s a big contrast. But I really liked [maths teacher] as well...as well, it wasn’t the teacher or anything it was just how hard it was for me, like I had to concentrate so hard to do well in Maths all the time and sometimes I just wouldn’t understand and I’d go home and like “oh my gosh, I’m so bad at Maths”, and I’d have to do homework, Sixth Form I’d just leave it, and yeah, Drama was just, not that there, there is obviously a lot of attraction in Drama with other people, in Maths its more like just do your work sort of, even though we talked a lot.

Helen’s discussion above produces many binaries. The first is the binary of hate/love. Her love of Drama will be discussed further later in this chapter when I will examine other subjects in more detail. The word, ‘hate’ evokes an emotional response from the listener and/or reader. In my earlier work (Shannon, 2004) Jane also used the word ‘hate’ to describe her experience of mathematics. Analysis of Jane’s story indicated that her hate of mathematics stemmed from how the curriculum was delivered while she was at school. She saw mathematics as being about procedures and rules and disconnected from her life. Helen reiterates this when she discusses above how she felt she had to concentrate so hard to do well in mathematics. She blamed her lack of understanding on not being able to concentrate and because she could not understand she then believed that she was “bad at maths”. Like Amy, Helen blamed herself not the mathematics and in Helen’s case she went even further to take the blame away from the teacher. Helen was quick to establish in her discussion with me that it “wasn’t the teacher or anything” because she “really liked” the teacher. Liking the teacher
or having a nice teacher are threads that appear in other transcripts and I discuss this in the following section.

“Nice teachers are good teachers”

For many students their feelings and emotional connection with their teachers play an important role in their experiences at school. This appears to be particularly so for the girls in this study. Feeling respected, relationships with teachers, teacher professionalism, the quality of interactions and, opportunities for learning in a way appropriate to the individual are seen as important to students learning mathematics (Averill & Clark, 2012). Eight of the girls in this study talked about their teachers and how they felt about them. The main focus of this section is to unpack their feelings about their mathematics teachers. Averill and Clark (2012) found that issues related to respect in mathematics teaching were very complex, combining many aspects of students’ experience but also linked to other factors such as cultural diversity. Cultural considerations were beyond the scope of this research, however, my research participants’ voices reiterate their findings about the complexity of discussing the likeability of their teachers.

During the interview process I tried to gauge the girls’ feelings about their mathematics teachers and explain their responses in relation to their positioning in Year Twelve mathematics.

I: Can you tell me about your maths teacher? About the year and how it’s gone.
Vicki: Yea. Um she was my maths teacher last year and she’s a good maths teacher. She’s also perky and nice and she um what else does she do?
I: What makes her a good maths teacher?
V: Well I’m passing so that’s all right.
I: That’s important?
V: Yeah and she sort of keeps you interested and she goes around and looks at your work and tells you that your doing good work and makes sure your doing the work and some maths teachers don’t do that.
I: And what about as far as the actual teaching of the work, does she have a particular style? What’s her normal way of teaching you things?
V: She writes lots and talks about it and gives us examples and takes us through the steps for examples. And that suits my style.

Vicki clearly like her mathematics teacher reflected in the discourse above where she describes her as “perky and nice”. For many students it appears to be important that the
teacher is “nice” and respected (see Averill & Clark, 2012). However, when I asked Vicki what made her a good maths teacher the instant reply was “Well I’m passing so that’s all right”. This response moved away from the comment about niceness to a direct comment related to achievement. At no point did Vicki comment on aspects of the teacher’s pedagogy but this may be seen to be implied by connecting good teaching to results, that is, passing the course. The perception of many students is that good teaching is related to how well a teacher explained the mathematics and if they provided opportunities for the students to progress mathematically so they could do well in tests (Anthony & Walshaw, 2010). This link between quality teaching and results can be viewed both positively and negatively. If teaching gives rise to good results then this may be seen as an important aspect of teaching mathematics. However, getting good results may not be a reflection of good pedagogy, it may just be a reflection of good assessment preparation (see Hagan, 2005). For most students this may be of more importance to them than experiencing a holistic style of teaching where thoughtful pedagogy allows students to become thinking, engaged, independent learners.

Vicki suggests that her teacher’s style suits her. The teaching style appeared from my observations to be the traditional approach of give some notes, talk about it, give an example and work through the example showing the class each step to solve that particular problem. Then students were assigned exercises to complete either from the textbook or on a worksheet. The set tasks were almost identical to the example used as the teaching point. For many students this may be a satisfactory approach to learning as they can feel a sense of accomplishment in being able to answer correctly problems fairly identical to the examples. However, issues arise when the students come up against a task that is unfamiliar and then they discover that often they may not have the tools to tackle it. The ability to problem solve outside of a normative situation can often be lacking. This can result in students only attempting the Achieved level questions in NCEA assessments as here they feel safe; the Merit and Excellence questions require stepping outside the comfort zone and if a ‘pass’ is all that is desired or required then no attempt to tackle the unknown is made.

Karen also discussed her mathematics teacher and how she made Karen feel as she was working in class.

Karen: But I had [teacher] last year as well and she was a really good teacher and I just have a lot of respect for her.
I: Good.
K: So naturally I would just do what she tells me.
I: O.k., so can you, can you give me a bit more detail and what it is that you really like?
K: About [teacher]?

I: About the fact that she is good, what does that really mean?

K: I don’t know, she has a really different teaching style, she’s really enthusiastic about it, like if she draws a good parabola she will be so happy for the rest of the lesson about it, just because she did a classic parabola.

I: Yep.

K: Yeah, and she’s just really nice to me. So, I think she’s just a good teacher. And I’d feel bad if I fail because then I feel like I’ve disappointed her.

I: OK, would you think she would be disappointed?

K: Oh yeah, because I completely bombed out this year, I was ooh, oh well.

I: Mmm, because it was a nice class.

K: It was really quiet, yeah, except for the boys behind me, just loud and annoying. That’s how it seemed to me.

I: What does she do that makes the class work like that, what does she do that’s different?

K: Umm, I don’t really know, she just, its her aura. Something about it, it makes you work.

Karen uses the words ‘good’ and ‘nice’ to describe her teacher just as many others did. She mentions other aspects such as the teacher’s enthusiasm and her aura attributing these characteristics of her teacher to making her feel like she should do the work. Interestingly, Karen suggests that she would feel bad if she disappointed her teacher. Karen says her teacher was “really nice to her” and then links this to her being a “good teacher”. Not once did Karen discuss the teacher’s particular style of teaching; she appeared to focus on how the teacher made her ‘feel’ rather than direct comments about the actual mathematics taught. Karen suggested that her teacher would be disappointed in her because she had “completely bombed out” that year. There appears to be a contradiction in what Karen was telling me in that she liked the teacher, thought she was a good teacher because she was nice to her but then tells me that she bombed out in mathematics; bombing out usually describes failing! Karen appeared to want to work and do the work but if she ‘bombed out’ then this may suggests that the work she was doing in this class was not productive in allowing her to experience success in the curriculum area.

Karen also links the idea of being enthusiastic with being a good teacher. Maybe she had not experienced this enthusiasm from a mathematics teacher in previous years and thus associated enthusiasm with being a better mathematics teacher. Davidson (2008) found that when a teacher was seen to show enthusiasm for mathematics this enthusiasm was likely to
extend to the students and result in them becoming more engaged and enthusiastic themselves. I also find it interesting that Karen comments on how loud and annoying the boys were in her class. From my observations in this particular class, there were a group of boys who did cause quite a substantial amount of disruption to the learning environment. The teacher was often disciplining these boys. Maybe the comments made by Karen about the teacher being nice to ‘her’ were in contrast to how she saw the teacher’s interaction with these boys; maybe the teacher was not so ‘nice’ to the boys her in view.

Sarah thought her mathematics teacher was also a good teacher but in contrast to Karen, she related this to how helpful the teacher was to her.

I: Just tell me about what its like in Maths and, and what the teacher’s like and how its been for you this year.

Sarah: Um, the teacher is really good, she’s like helped me with most of the things that I get stuck at and, I understand the way that she teaches.

I: Can you explain that?

S: Um, well, with most teachers I’ve had like in the past, they explain it but um they don’t explain if fully, like, they sort of explain a bit about it then sort of you do the work, and see if you can I don’t know, if you get it or not, but um, in Maths now I guess ummm, [teacher] put everything maybe into, like phased it easier. So I can understand, but.

I: Sort of more everyday language?

S: Yeah, more everyday language.

I: So what’s her general sort of teaching style, what’s a normal Maths lesson like?

S: Um, notes on a board, and then exercises. That’s about it.

I: And what does she do while you’re doing the exercises?

S: Um, she goes around the room helping people. And makes sure everyone understands.

I: So you feel she keeps in with you?

S: Yep.

I: Or do you sort of have to call her over?

S: No, she usually comes round sees how everyone’s going.

Sarah’s transcript contains many interesting points, including the ideas that her teacher was good because she helped her when she was “stuck” and also because she moved around the room to check the progress of the students. Many students value a “togetherness environment” (Anthony & Walshaw, 2010) where they believe that respect within the classroom between the teacher and students nurtures their learning and makes them feel
valued and cared for. Sarah’s description of her mathematics classroom matches my observations where the normal structure of the mathematics lesson was notes on the board followed by exercises either on a worksheet or from a textbook. For many students there is a perception that mathematics is all about numbers, writing “stuff” down, and the teacher putting “stuff” on the board (Davidson, 2008, p. 6). During the section of the lesson where the notes were written on the board the teacher was in control of the class and directed the learning. She asked odd questions of the students, but I noted in my field notes that the “questions were closed- questions”. The questioning required a response to a specific skill. An example in my notes was “What is 2x -5x?” The correct answer was -3x, this is a basic recall of an algebra simplifying skill that most Year Twelve students should be able to do. There was no higher-level thinking required to answer this question; it is just a right or wrong answer. This right or wrong scenario is a very common aspect of many mathematics classrooms (see Black, Mendick, Rodd & Solomon, 2009) The students may often feel success for getting the correct answer and the teacher may feel success with their teaching because the student got the right answer. Of course, when a wrong answer is given then the opposite emotions usually appear resulting in low engagement and aversion to mathematics (Lewis, 2013).

In Sarah’s mathematics classroom only a few students actively volunteered to answer questions and the teacher very rarely looked beyond this group of active participants for responses to her questioning. At the end of the note-taking, which usually included a worked-example for their notes, the teacher usually asked something like “okay, any questions?” or “everyone understand?” I mentioned in my observation notes that when these types of questions were asked there was usually a “hush of silence”. This “hush of silence” became my written description during this research; how I described in my field notes these frequent occasions, where the students either sat in silence, avoided eye-contact with the teacher, or turned to begin to chat to their nearby classmates. This was a daily part of the classroom discourse, followed by the teacher moving to write on the board the next activity or to hand out a worksheet.

Sarah indicates that the teacher then “goes around the room helping people. And makes sure everyone understands”. It is almost as if the “hush of silence” leaves the teacher not really knowing whether the class do really understand and the next step is to find out by moving amongst them. Unfortunately, this is where my opinion and Sarah’s opinion of what the teacher does next diverge. Sarah believes that the teacher is helping the students and checking their understanding. Interestingly, in my notes from observations of this class, I recorded, “Sarah never once had a discussion with her teacher about her work that went
beyond the teacher asking either “ok?” or “know what you’re supposed to be doing?” and Sarah responding “yes!” The teacher did indeed move around the room but most of the interactions were to check that the students had started the task, were staying on task, or that they were not talking to their peers. Sarah appears to link the movement of the teacher around the room with an idea that she is checking mathematical understanding. I would suggest that the teacher moved around the room to check task initiation and completion as rarely was there any mathematical engagement that went beyond a quick check to see if an answer was correct on a worksheet. I never saw a discussion about a task that went further than the teacher showing a student an error in their method and correcting it for them. Even when this scenario presented itself, the teacher was more likely to show the student what to do rather than helping the student to work it out themselves.

Most of the tasks were quite similar to the examples shown on the board, and when longer word problems were given, often at the end of a worksheet or page from a textbook, only one or two students attempted these in class. Often these word problems were set as homework but in my observations I never saw this homework marked or discussed, although this is not to say it never happened, just not in the time I was in the classroom. Sometimes the teacher would read out answers to the problems at the beginning of a task and I would suggest that she often took this part of the lesson as evidence of learning and understanding, that is, she rightly or wrongly, assumed that if the students were marking their work, that they had done it and that they understood the lesson’s work. Sarah may have also believed that if she did a few questions and got them right that she too understood the required work. I never observed Sarah go too far beyond the first few questions in any set task and I never observed Sarah ask her teacher for any assistance. Sarah’s notion of a good teacher appeared to relate to the teacher teaching her some content, providing her with achievable activities and checking that she can do the work. Sarah’s expectations of her mathematics teacher differed from my expectations as the researcher in her classroom where I expected more student engagement and more student directed learning and progress beyond the backboard tasks.

Amy’s discussions with me were also interesting and reiterated the idea of a good teacher is one that is also nice.

I: Right, o.k., and what about your teacher, do you enjoy her, her style?
Amy: Yep she’s good, yeah.
I: O.k., how’s she good?
A: Um, she’s just sort of friendly and um, you know, she’s got sort of a good attitude towards maths stuff and yeah, she’s like a nice person, good sense of humour and stuff, so.
I: You said she’s got a good attitude towards it, what do you mean by that?
A: Oh, sort of like um, all happy and ah, just eager to teach us kind of thing.
I: Do you think she likes Maths?
A: Yep.
I: How can you tell?
A: Ah, just by her sort of sense of eagerness, I think, yeah.

Amy talks about her mathematics teacher being friendly, having a good attitude, a good sense of humour, and that she appears to like mathematics. Amy suggests that she can tell her teacher likes mathematics because of her “sense of eagerness”. These characteristics appeal to Amy and help her to feel comfortable with this particular teacher. These comments are similar to those of Vicki’s where Vicki used words such as “enthusiastic” and “happy” to describe her mathematics teacher. Like Vicki earlier on, Amy does not mention any pedagogical characteristics of her mathematics teacher. She only focuses on the personal qualities of her teacher, that is, how this teacher makes her feel. When I asked about the teacher’s “style”, I was hoping that Amy would talk to me about how her teacher taught her mathematics. It appears that Amy judges teaching more on personal qualities of likeableness than on the quality of the mathematical experience based on engagement and learning. These themes of nice and enthusiastic as being characteristics of a good teacher also appeared in Ngaire’s interview.

I: No, alright, so um, so describe your Maths teacher to me
Ngaire: She’s really nice, because she’s really really enthusiastic about what she’s doing, I think that’s why she gets so angry at us for not listening lots of time
I: She didn’t seem that angry to me
N: (laugh) nah, she’s really, she’s pretty good about it, but she’s, you know she’s really enthusiastic about it and I think she’s pretty good.
I: Do you like the way she teaches?
N: Yeah because she moves things quite quickly and in different ways.
A: OK, describe her teaching style to me. What’s a normal lesson like?
B: Um, she’ll normally show us something, get us to do a few exercises on it and then move onto something else. And not waste time

Ngaire agrees with Amy and Vicki that being enthusiastic about mathematics makes her feel like the teacher likes what she is teaching. This perception of the teacher enjoying
mathematics themselves seems to attract good feelings/emotions from the students. Ngaire also likes the fact that the teacher moved the lesson along at a good pace. Ngaire was one of the more able students in this particular mathematics class and it appears that she did not like to “waste time” in class. I interpret this as Ngaire liked the way her teacher taught the content and then let them move on to the set exercises. It would appear that Ngaire liked to be allowed to work at her own pace on the tasks set by the teacher after the initial explanation of the content. Ngaire may differ from other students here because my observations of Ngaire in class were that she was more able than many of her classmates and she usually understood the work quite quickly and did not need further explanations. In my classroom observations, Ngaire generally worked alongside the boy she sat with and together they solved any problems they had with a task. She did not ask the teacher for any help, she worked reasonably quickly, finished a task and then sat and chatted off-task to those seated near her. I will discuss group work more later in this chapter, but my concern with Ngaire was that she seemed content to get the set tasks complete and never asked to be challenged with harder work. Like Sarah earlier, task completion was her main goal but for Ngaire it was as quickly as possible so that she could move onto to her next goal, which, to me, appeared to be to have plenty of time to sit and chat to her peers. The mathematics teacher did not appear concerned that Ngaire and her immediate group of peers were finished and then off-task, she asked them “have you finished?” and then moved on to the next group. During my time in the classroom the teacher never suggested that Ngaire should attempt more or harder tasks. Ngaire appeared to have sorted out how to ‘play the game’ with her teachers where she knew that if she got her work done, even if it was with minimum effort on her part, she could keep them happy. She told me her teachers were in general “fabulous” at her school. I asked her what she meant by this and she explained:

I: Can you elaborate on that as to what makes them fabulous?
Ngaire: Um, they’re really good because they, they don’t really mind what you’re doing as long as you’re learning or the feeling that they do mind (laugh) but generally, they don’t really mind as long as you’re doing what you’re supposed to be.
I: So you can sort of be a bit more independent.
N: Yeah

Ngaire thought that her teachers did not mind what she did in her classes as long as they thought she was “learning”. Her use of the word learning is problematic here because to me learning means understanding, but I felt, from her previous comments above and my
observations, that Ngaire did not equate learning with understanding the work but with finishing a task such as a worksheet or problems from a textbook. This seems to be reinforced when she says “as long as you’re doing what you’re supposed to be” which implies that she knew that to keep her teachers happy all she had to do was complete the tasks or at least look like she had. From my observations in the mathematics classroom, in particular, Ngaire could have just put a tick next to her mathematics questions to indicate they were correct and the teacher, as she walked by, would see they were marked, take that as an indication of correct and completed work, and think that Ngaire was engaged and learning. Not that Ngaire ever did this, but I would suggest that if Ngaire had just put ticks next to her work without actually checking the work with the answers at the back of the text, the teacher would have just assumed Ngaire had marked everything and it was all correct. The teacher was relying on the honesty of Ngaire, she never actually stopped and watched Ngaire work her way through a problem, she never questioned Ngaire on her thought processes or understanding, the tick was all that she looked for and this was used as an indicator of Ngaire successfully learning mathematics in her classroom. I asked Ngaire if this made her feel “independent” and she agreed but this style of independence in mathematics is quite different from the type of independent learning I observed in other subjects such as Fabric Technology and I will discuss this further on in this chapter.

Ngaire and Amy both liked their mathematics teacher, however, this liking did not appear to be related to their engagement in class, it seemed to be more about the teacher making them feel comfortable in class. This was also apparent later in Amy’s interview when I questioned Amy about her future plans. I have included this excerpt here because the last few statements resonated with my observations in my classroom visits.

I: And so what are you going to do when you know next year, sort of sorting out your subjects, what are your plans for after leaving school, do you know?

Amy: Ah like when leave school. Um I want to do Tourism Hospitality sort of thing.

I: Is that something that you can do at school?

A: No, you can do Food and Nutrition, but um, to help you get in, but I don’t enjoy that particular teacher so I didn’t take it this year.

I: I’m getting the impression that the teacher makes quite a difference to your enjoyment of the subject.

A: Yeah.

I: Can you elaborate on that a little bit, I mean, what is it, what is it about a teacher that would make, that makes you enjoy a subject more than.
A: Um because they could be like a horrible teacher be really mean and I guess you don’t want to be in a class for a whole year with that sort of.

I: So when you say horrible, what sort of things are you talking about here?

A: Umm, strict. Um or also in some cases like not knowing what they’re talking about and not teaching you properly or something like that.

I: So what do you mean not teaching properly?

A: Oh like, um, they sort of, like you ask them a question, they sort of avoid it or they just like give you work sheets all the time and you don’t really learn anything. Stuff like that.

Amy reflects on her future career choice and how she opted out of a particular subject, Food and Nutrition, because she did not like the teacher. I questioned her more generally about what kind of teacher makes her enjoy a subject and she talks about a “horrible teacher” as being “really mean” and not wanting to be in a class all year having to be taught by this type of teacher. I was interested in the words horrible and mean and tried to get Amy to unpack this some more for me. She indicated that for her horrible meant strict and then continued to state that horrible might also mean a teacher not knowing what they are teaching or not teaching properly. To me these ideas surrounding Amy’s view of a horrible teacher contrasted in many ways. I asked her what she meant by not teaching properly and to my surprise she linked this to the teacher not answering her questions or avoiding the question or giving her worksheets to do in class or Amy not feeling as if she is learning anything in the class. There was so much going on in this section of the interview and I was getting quite confused by this stage wondering which teacher or teachers Amy was talking about. I asked her “So is a horrible teacher your last year’s Food and Nutrition teacher?” and surprisingly she replied “kind of but actually more Mrs [mathematics teacher] from last year. She was hopeless, I learnt nothing because she knew nothing about maths”.

Amy had constructed some interesting binaries here. Firstly, horrible meant mean and strict and then horrible meant not knowing the content and not answering questions and horrible also meant using worksheets as a method of teaching. In contrast then, nice would mean a teacher who is not strict, who answers questions and who does not use worksheets all of the time. What I found most interesting about this was that in my observations of Amy in mathematics this year I never saw her ask her teacher a question and most of the classroom activities were worksheets based. Yet Amy liked her mathematics teacher in Year Twelve better than her teacher in Year Eleven. The Year Twelve teacher was nice, whereas the Year Eleven teacher was horrible. I had observed both of these teachers and in my view they were pedagogically very similar; they both taught the same content in very much the same way and
they both used very similar resources and worksheets. The only difference, in my opinion, was that the Year Twelve teacher was younger. I guess what this shows is how a young sixteen year old student has a totally different perception to me of what makes a good/nice mathematics teacher, perceptions I imagine that would be very difficult to alter even if I was to show her the recorded evidence I have as part of this research. What concerns me is that this perception of what makes a good/nice mathematics teacher is not pedagogically based and not backed up by achievement results or an overall enjoyment of the subject, it is maybe just a personal response of a young female student and that this response may have impacted on her enjoyment and engagement with mathematics at school.

Another reason the girls gave for liking or not liking their mathematics teacher was based on the quality of the teacher explanations of the content. Helen gave quite a bit of her personal insight into how her teacher explaining things well helped her mathematical learning. Harriet’s comments corresponded with Helen’s but she was also in agreement with Leanne and Joy who both told me how they felt disadvantaged in mathematics because of their perception of poor quality teaching.

Helen:  ... Mr [teacher]’s like the best teacher, well he was for me anyway.

I:  Mmm hmm, what made him good?

H:  Um, I didn’t feel scared to ask anything, he explained everything in two ways like he’d explain it for the people who just understand once, people like that which is very lucky, then he could explain it to me with pictures, because I see through pictures. Which is why I’m really good at Geometry and all that sort of stuff. And, yeah I got Miss [teacher] for Sixth Form, Miss, is it Miss [teacher] ah, the teacher with the long skirts. Yeah, I got her and stayed for one of classes and just knew it wasn’t going to work, and so I changed to Mr [teacher] again which was hard to do but I did it because she just wrote the notes up on the board and didn’t really explain anything, and that’s fine for some people but not for me.

I:  So tell me about how he, you said he, some of it he just taught and the kids, oh some students just got it. So what did he do, can you explain a bit more what he did for you.

H:  Um, he sort of always knew I’d struggled a bit by but was willing to work hard. So he’d like, write the notes up on the board and explain it through steps and I’d try and keep up, but if I didn’t know anything I’d like put up my hand and he’d come over and explain it once more and give me, um, easier things to do, like just go back a step, I often forgot, forgot the first step, was when moving up from in Sixth Form, so he’d explain the Fifth Form stuff to me again and it made the Sixth Form more easy.
Helen had started the year with one teacher but made a decision very early on to move classes so she could have her preferred mathematics teacher. She appeared disillusioned within one lesson with the first teacher after experiencing a class where she was given notes to copy and not enough explanation. There also appears to be some associated fear of asking this particular teacher for assistance. I am not sure where this fear originated from but my suspicion is that Helen had been taught by the second mathematics teacher the previous year, had become used to his teaching style and interaction with her and that as soon as she arrived in the new teacher’s class she experienced a different style and was not prepared to give this teacher a fair go. Helen made an instantaneous decision that it was not going to work for her.

The quality of the explanations came through very clearly in Helen’s discussion of what makes a good teacher. Alongside this was an appreciation of being shown things in many different ways and the teacher persevering with her when she was struggling with the work. Helen appears to appreciate the relationship with this teacher and there seems to be a respect between them that allows her to engage with her mathematics even when she was struggling. Helen’s experience in this class made her feel positive emotions and this seemed to help to dispel some of her anxieties about mathematics. These positive emotions may help to raise achievement activities and outcomes in mathematics (Evans, 2000). Unfortunately, Helen was one of the students who did not continue with mathematics the following year so even though she liked her teacher this did not keep her studying mathematics in Year Thirteen.

Just as Helen described her mathematics teacher as the “best teacher” she talked about her biology teacher as a “great” teacher in much the same way. Helen is actually very complimentary of most of her teachers as can be seen below:

Helen:  Oh Miss [Bio teacher] is such a great teacher. She’s one of like, her and Mr [teacher], our English teacher in Third Form and um Mr [maths teacher], and one of my Art teachers from long time ago, are like my favourite teachers. She’s really good, she explains things in all different ways you can possibly think of people learning. Because that’s the way I learn, and High School people learn different ways. And um, she [Bio teacher] teaches a class down there for anyone who wants to come, she’s pretty much good at everything, she used to be a Maths teacher, and um, yeah she’s helped me a lot.

I:  Mmm, so there’s quite a group of teachers there, so it’s to do with the way they explain things that makes them good, or what, can you elaborate on that or?

H:  I don’t know, just feel really comfortable around them and stuff, I mean I feel comfortable around all my teachers they all really nice, I really like [this school’s] teachers.
I: Mmm, every girl that I’ve interviewed has said you know that they really like this school. What is it that makes [school] really special?

H: Um, I don’t know, its sort of, I mean I’ve never come against like bullying or anything like that, except for when the juniors get a little bit rowdy and stuff (laugh), but um, I’ve never really had any problems with it, and the teachers just seem really nice and helpful and they get grumpy but you know, that’s to be expected. You know, just seems very relaxed and family like here, most of the time

Helen talks again about how when teachers explain things well this allows her to learn well and to enjoy their classes. She also emphasises the importance of feeling comfortable around them and that they are nice and helpful. Once again, like many of the girls, the word “nice” comes up many times. “Nice” is a complex word to unpack but in the context of Helen’s transcript it appears closely linked to the discourses surrounding quality of explanations about the content and being able to relate to her and to her style of learning. Helen appears to need things explained in different ways and in contexts that she can understand. I spent some time watching Helen’s biology teacher and was amazed at the quality of interaction in this class.

The biology class was large; when everyone was present there were twenty-seven students. The class environment at first appeared to be quite disorganised with the teacher popping in and out to get things, asking students to do revision and finding them just chatting rather than working. However, when she drew them to attention they all responded quickly and she provided fun, interactive lessons using a variety of visuals, even acting out part of one lesson to the delight of the students. This teacher cleverly revised past lessons, used analogies, and questioned in a way that drew out ideas from the students instead of just telling them. I could feel the respectful environment in this class and there was a high level of comfort apparent from the level of questioning that came from the students themselves. This teacher was also very aware of who was and was not working well; she often spoke to students before or after class to reiterate her expectations for their learning or to praise work well done.

“Other subjects are fun”

The way in which the girls talk about school mathematics is in contrast to how they describe many of their other school subjects. One of the most common discourses to appear is that other subjects are ‘fun’. None of the research girls described school mathematics as fun, however, eight of the girls mentioned other subjects that they enjoyed and used the word ‘fun’ as part of their description of their experiences in these subjects.
Sarah talked to me about her biology teacher:

I: What’s biology like?
Sarah: Oh great, really fun, um, I don’t know because it’s because I’ll always look forward to bio because probably with Miss [teacher], she teaches like so fun, we all enjoy it like.
I: What does she do that’s fun?
S: She just sets up different activities and um, yeah just, to do like um just experiments and stuff…she has a really lively sort of approach to teaching.
I: Does that help make it fun?
S: Yeah.

Sarah uses the word “fun” to describe her biology class. This is very much in contrast, a binary opposite, to the description of mathematics as boring given in the first section of this chapter. Sarah explains that fun is related to the types of activities that she does in biology. These activities are the practical components of the course such as the experiments, but also just the way that this teacher engages them. Sarah told me that they “regularly did lots of hands on activities” and that “even though the class was very big it did not feel big because they were always working and doing stuff”. She described her teacher as having a lively approach which I read as the teacher enjoyed what she was doing. It appears that if the teacher looks like she is enjoying herself and having fun then the students have fun also.

Other students mentioned the word fun when they talked about other subjects. Polly told me that her favourite subject was drama because “it’s just different than the others, it’s probably a bit more like, I enjoy doing drama stuff so it’s quite easy. She also said she liked English but in contrast to drama she said “I would probably like English more except I’m not very good at it. I just can’t always grab the concepts and stuff”. For Polly’s enjoyment was closely linked to whether she found a subject easy or difficult. I asked Polly to tell me some more about drama:

Polly: I suppose it’s just like you get to work together in a team and can make up plays or acting, it’s just fun.
I: Do you get to have fun in other subjects like that?
P: Umm, not to the same extent. It’s like different I mean TIM (text and information management) is normally fun because you’ve got your working with people and you just talk while your typing and stuff and that’s OK. But yeah. Because you’re all in time you would all sort of doing your own thing.
The key discourse above is that Polly likes to work with other students. In drama they were working in groups to produce a drama item. My observations in the drama class were that the students had been given an assessment task to produce an item and then the teacher left them to work together with very little teacher input. This was very like the classroom environment in fabric technology, which I will discuss later, but in drama the final assessment grade was awarded to the whole group. When I observed the drama classes the students would arrive in class, find a space in the very large drama room, pull out costumes and props as required, and work collaboratively for the whole lesson. The teacher was very much in the background, guiding when necessary but mostly leaving them to problem solve issues as they arose. The students used lots of different spaces in and around the drama room; some even went outside to do their work on fine days.

Helen, Harriet and Tara also spoke positively about drama:

I: You enjoyed Drama?.
Helen: Really liked it.
I: What’s special about Drama?
H: I really can’t describe it, our class must be the weirdest class in the whole world having Miss [teacher] as a teacher, you met Miss Welsh? She’s crazy, but um. Yeah we did some fun stuff on that day you came actually, we were doing dancing weren’t we? And stage setting and lights. Yeah she basically just leaves us to it, but she’s going a bit nuts actually, getting pretty old and, but yeah, I couldn’t imagine it without her really, had her since Fourth Form. And Third Form you get um, this other teacher, what is her name? She’s really sweet but, yeah, Drama’s really cool, learn a lot, we do really cool Drama trips to Japan and East Coast and um we get to do all kinds of stuff and produce lots of shows.

I: So tell me what it is about drama that sort of makes you feel good about it?
Harriet: Oh I like drama because usually I’m pretty hyper and so we just get up and do fun stuff.

Tara: Yeah, it’s great, I like Drama, I, I’m, I enjoy Drama, its good, but I, I mean there’s nothing about Drama that I don’t like, you know fun and that kind of stuff ...I enjoy that big open area that we are working in and not having to sit at desks.

I: What does the teacher do there that’s different from other subjects?
T: Oh she is great and fun. She sort of takes, gives you a guideline and you, you use that and you improvise and do it yourself or in groups.
I: So in Drama does the teacher tell you what to do or?
T: Oh, well she’ll say oh, she might give you a scenario or something and you’ve got to do or, how you, oh in the form of a soap opera’s style, and you get to be creative and do your own thing. You don’t sit around talking and mucking around because you knew you had to get it done and you enjoy doing it.

When I listened to this and reread this transcript I can feel the positive feelings and emotions that all of these girls have for drama. Like Polly, they all used the word fun and the said how they enjoyed not only the subject and how it was taught, but also the space of the classroom. Tara said how she did not have to sit at desks which is what happened in subjects such as mathematics, There were many other subjects I observed where the students did not have to sit at desks and were free to move around more. These subjects included: food technology, music, fabric technology, art and TIM.

Art was another subject where the students were able to move around the room. Karen talked to me about art and how that was fun and how she liked the teacher:

Karen: Yeah, like the people in there just got on so well, and we just lots of fun, I got on really well with Miss [last year’s art teacher], and this year I have Mr [teacher]. I’ve had him before, I had him in Fourth Form, and I’m on his good side, I just sort of sat there and take the shit out of him and he knows I do and he just laughs at it. Yeah, good fun, we have a lot of fun in that class.

I: So how is art different to something like maths, what do you do in art that makes it fun?

K: That makes it fun, um, it’s sort of our own thing, and it’s different as in we’re not forced to do the same thing and, it’s not quite work, we like to make noise.

I: And you have to be quiet in maths?

K: In maths it’s just better off that way because you have to concentrate because it’s so much harder, it requires so much more thinking, and art’s just so much more relaxed, and easy going. And it’s just fun.

Karen felt comfortable with her art teacher. Being on the teacher’s “good side” and being able to have a laugh with him added to her enjoyment of art. Like Tara and Polly, Karen used the word fun to describe her experiences of art and she related this to the variety of the learning activities in class and being able to make noise in class. My observations in both of the art classes were that the students were free to move around, observe each other’s work, discuss their work, but also chat off-task, which they seemed to be able to do at the same time as working on the set tasks. That is not to say there were not moments of very quiet focussed work from the students and in fact, Vicki another girl from my research group, liked to work
individually and quietly in her art class but did not seem perturbed by the busy noise around her.

Karen’s transcript above also contains some interesting binaries when she contrasts her experiences of art and mathematics. In art there was noise but in mathematics there was quiet. In art it was relaxed and easy going, however, in mathematics it was about concentrating, it was harder, and required more thinking. In art students got to “do their own thing” whereas in mathematics you were told what to do. If we think of binaries as having a hard versus soft option then Karen clearly places mathematics on the hard side of the binary and art on the soft and clearly articulates that mathematics is not as enjoyable as art. What this does is position mathematics in binary opposition to all the subjects that my research participants talked about in terms of fun and enjoyment. Similarly, Helen also discussed art but she also mentioned English in her interview.

I: How does a teacher teach art that’s different to teaching maths, what are, what are some of these other teachers do that makes it quite different to the maths experience?

Helen: Maths is different to everything really, because it’s sort of like, well it’s sort of the same as science really, because it’s sort of like um, some things just happen because they just do and there’s nothing that you can explain about them, they just, you’ve just got to move along in class with what the teacher says, and um, art is more probably individual, you can choose what you want to do, and in maths you’ve got to do this and that. You’ve got to get the basics first, with art you can probably make a mistake in the beginning and keep going, but um, I’m not sure, maths is um structured and sort of more different (laugh). Because with English you can choose like what kind of, with the novel you’re studying you can choose your question for the novel and you can prepare it and stuff, but with maths there’s not choice in it, you don’t know what achievement questions they’re going to give you, you do have a fair idea but um, that was my strategy for last year, or the year before that, was to learn all the achievement questions and hope to get it.

Helen uses the words “choose” and “choice” a lot in the above transcript. She compares mathematics to art and English by comparing how she worked in class and it appears that she liked the freedom of choice given to her in both art and English. Helen believes that she was free to make ‘choices’ in art and English, but in mathematics there was no choice or perhaps it was more of a “forced choice” (Davies, 1991). She believed that because she could chose which books to study or which question to answer that this meant she had more control over her assessments in English. It was as though Helen had a presence in English as she had access to subject positions where she had the right to ‘speak and be heard’ and through this
she could become the “author of [her] own multiple meanings and desires” (Davies, 1991, p. 51). In mathematics, Helen felt that she was forced to have to learn all of the mathematics because she could not predict what would appear in an assessment. This did not allow Helen to forge something new, she was constrained by the content in mathematics. The only possible action in mathematics was to do as she was told to do; she had no “chosen line of action” (Davies, 1991, p. 46).

My reading of Helen’s transcript makes me wonder if Helen felt like she was on an uncomfortable train ride in mathematics and she had to stay on track with the requirements of the teacher and the course and continue on with the ride until the end. She said mathematics is structured and not like art where you can make mistakes and then correct them as you go. She also explained how in mathematics she could try and guess the type of questions she might get in the assessments but that she could never guarantee that she would be able to do them and get them correct. It is almost as though Helen sees mathematics as not allowing for any second chances, that is, you either get it or not or you either pass or fail. Another interesting finding was that many of the girls talked about assessment whenever they described their experiences of mathematics to me. Assessment appeared to be a major focus for these girls in mathematics, but they did not mention assessment tasks or requirements when discussing their other subjects. This is bemusing because in NCEA there are assessment tasks for every subject both during the year, as internal assessments, and for many subjects at the end of the year, as external assessments in examination time. It appears that the assessment focus is not such a big thing for these girls in their other school subjects; it’s part of their courses but perhaps does not drive their learning as much as it does in school mathematics.

Helen describes mathematics as “different” to every other subject except science, which she said had some similarities. Mathematics and science are often classified together as ‘hard’ subjects (Nardi & Steward, 2003). Her description “some things just happen because they just do and there’s nothing that you can explain about them” sets mathematics up as having some sort of mystical qualities that she appears unable to quantify. It is almost as though she does not understand how these subjects work and that they are surrounded in mystery for her. Karen told me later in the interview that the way she copes in mathematics is to learn all of the achievement level questions and practise examples over and over again. She said she does not even try the harder questions because they “confuse her too much” and they “take too much thinking”. She kept telling me she “doesn’t get maths” and I would suggest that she had worked out a coping mechanism that she utilises in class and in assessments and she hoped that would just “get her through the course”. I did not feel there was any sense of enjoyment of mathematics for Karen like there was in art and English.
Amy, like Karen, also enjoyed English more than mathematics. She told me that if she enjoyed a subject it drew her to that subject more and made her feel better about going to class. She told me that mathematics as not enjoyable:

I: Which subjects give you that enjoyment?
Amy: Um, English.
I: So what’s special about English?
A: I don’t know, maybe I just like writing I guess so, I like the class and it’s just, I like, I like the people sort of thing, like a lot of friendly people and the teacher, I don’t know, she’s just good at what she does I guess. It’s just really interesting and enjoyable. I used to enjoy history too, I used to go to history quite a lot because that was, I used to like that because we’re doing um Nazi Germany But yeah, then we changed topics to the Vietnam war, I didn’t like that so I started missing classes. But yeah and I, I used to really like going to typing (TIM), but now the teacher is just annoying so (laugh) I just sit there and try and understand what to do.
I: It seems to me in TIM you get to kind of just get on with it by yourself anyway.
A: We just have to because he won’t help us so and right, it is frustrating.
I: Are you going to do TIM next year?
A: Yeah probably, just because I like it so.
I: What about English?
A: I obviously really enjoy English, but I haven’t still really been able to tell you what it is exactly about English that makes it really enjoyable. Maybe just because I find that I can actually do it like. I enjoy going because I know how to do, I can write essays or whatever and whereas maths I don’t know how to do it, because I, it’s, I find it really hard. That’s why I don’t enjoy it.

Amy appears to like most of her subjects except mathematics. Liking a subject for her depends on a few different things such as whether the class and teacher are friendly and based on whether she gets to work independently. She differentiates between her English and mathematics teachers by suggesting that the English teacher may be better because she knows what she is doing. This leads me to think that Amy did not feel the same way about her mathematics teacher. Amy had a change of teacher for TIM during the year and at the time of the interview there was a relieving teacher in her TIM class who was not a specialist in that area. Even though Amy suggests that her new TIM teacher was not helping her with the work she had not stopped enjoying the subject. She liked working on her own or with others in the class and it appeared that they were able to solve their own problems in class as they arose with very little support from the teacher. I felt that this was not the case for most of the girls.
in mathematics. They seemed much more reliant on the direction and guidance of the teacher at all times. Amy sums up her feelings when she says she does not like mathematics, that it is hard, and she did not enjoy it. When other subjects were hard she seemed more prepared to find a way to get through the difficulties whereas for mathematics there did not appear to be this same willingness to come up with a way to problem solve through the hardness of the subject.

Joy was in the TIM class as well. She reiterates most of what Amy said about having to self-manage in this class. She also talks about her fabrics technology class and as with many of the other girls and other subjects the word fun appears again.

Joy: TIM, its mostly you do your own thing, the teachers don’t know anything about computers so, we have to teach each other. And we get all the work done on time, we do most of it at home, and usually play games in class, because the teacher couldn’t control us, that was fun, but we got the work done.
I: What about fabrics?
J: Fabrics, fabrics was fun, because um the teacher was real nice, she was real good at helping and everything and yeah.

On the other hand, Joy spoke about having already failed mathematics and how “I would’ve hated Seventh form maths”. I asked her why and she replied: “Because I can’t do sixth form maths”. She later went on to discuss mathematics and some of her other subjects.

Joy: It was a cool subject in Third Form, Fourth Form and Fifth Form, and I was sort of obliged to do it in Sixth Form.
I: Can you tell me why you felt obliged?
J: Because I did it all those other years, maybe because my Dad’s a technician, ahh felt like I should do maths, and because it’s easier than physics, so.
I: Which subject would you say would be your favourite?
J: Um, I’m not sure, maybe between fabrics and physics.
I: So what is it about those two that makes you enjoy them?
J: Physics is hard, I don’t get most of it, but its fun.
I: Okay, so tell me about what makes it fun?
J: Just, it in general. I just like all the problems and everything and.
I: Because a lot of people say that maths and physics are very similar, so what makes physics fun and not maths?
J: With physics it usually has certain things, like it has velocity and speed and all that, and in maths, it doesn’t really have that, it has all these
other questions and you have to put them into your own problem, yeah
where in physics you have, you already have um a formula or
something so it’s different.

Much of Joy’s narrative suggests that other school subjects were seen as more fun than
mathematics and this is similar to Jane’s perceptions of her school subjects (Shannon, 2004).
Joy talked about physics being more ‘fun’ and indicates that she liked the context of the
problems in physics. What is different to Jane’s experiences is that Joy enjoyed physics, a
school subject traditionally perceived as a boys’ subject in the same way that mathematics is.
Joy was engaged in physics even though she later suggested it was for the boys and it was too
difficult for her. The practical work and links to the real world were different to how Joy
experienced her mathematics classes. Joy maintained her interest in physics even though she
found the content challenging. In mathematics, I observed, she was disengaged from the tasks
and in all aspects of the subject she had withdrawn from what was happening in the classroom
around her. For so many of the research girls, like Joy, it was more appealing to stay with the
subjects they enjoyed than to persevere with mathematics.

Summary

The discourse of disengagement in school mathematics is common and contrasts with
the research girls’ experiences of their other subjects. Mathematics is described as hard and
boring and evokes a range of emotions for these girls as they struggle to see the worth of
continuing with this subject at school. They find the work difficult, they focus on assessment
rather than learning and they do not enjoy the way it is taught. The girls appear to have many
ideas about what a nice teacher is and when they respect the teacher they tend to engage in
more positive ways. However, for the most part, the girls preferred their other subjects and
subject teachers to mathematics and their mathematics teachers, often describing their other
subjects as fun and expressing far greater levels of enjoyment in these subjects. Only two of
my research participants wanted to continue with mathematics in the year following from this
study. For the other ten disengaged girls, their other school subjects provide them with
happier pathways for learning and because of this their mathematical journey ended.
CHAPTER EIGHT: CONCLUSION

This research examined the experiences of fourteen Year Twelve girls. I collected a range of qualitative data during intensive observational periods at their schools and from interviews with the girls and their teachers. Year Twelve was chosen, as this is the first year where mathematics is no longer a compulsory school subject in many New Zealand secondary schools. Research into the emotions that girls experience within the spaces afforded them in their school subjects has assisted in unpacking their perceptions of school mathematics and how this impacted on their like or dislike of that subject. Analysing these emotions was undertaken using a feminist poststructuralist lens as this allowed for a critical consideration of the multiple, and often, competing discourses that these girls found themselves and/or positioned themselves in. Poststructuralist tools allowed for (re)telling, unpacking, and troubling the stories of how this group of female students experienced mathematical space in the context of their everyday experience of secondary school.

This final chapter highlights the key findings from this study and provides a discussion of the research questions posed in chapter one. It also presents ideas about the relevance of the results for those involved in the mathematics education. The setting of this research is particular to the New Zealand context, however, the research focuses on issues that might be considered to be more applicable to the wider mathematical education community. Discourses of disadvantage in New Zealand educational circles have focused on boys’ underachievement in the school system and the small numbers of students entering STEM pathways post-school (Forgasz, Leder & Tan, 2014; Fox, 2003; Renert & Davis, 2010; Schaer, 2004; Velayutham, Aldridge & Fraser, 2012). This focus has drawn the attention away from the many cases where girls of all abilities choose lower-level mathematics courses, opt out of mathematics altogether, or just fail to engage with, and enjoy mathematics. The research, reported in this thesis, addressed the gaps in the literature by contrasting the girls’ experiences in mathematics to their experiences in other more traditional ‘feminine’ school subjects such as drama, food technology and English, to highlight differences and unpack girls’ preferences for their learning experiences.

Research Questions

This thesis has addressed two research questions: ‘What are girls’ experiences of secondary school mathematics?’ and ‘How do girls’ experiences of mathematics compare and/or contrast with their experiences of their other school subjects?’
Investigating these questions required analysis of the concept of mathematical space to consider how girls are positioned and constructed in mathematical discourses in their everyday lived experiences in mathematics classrooms and how they are influenced by factors controlled by others and by the environment they function in. Hegemonic traditions and masculinised methods of teaching and learning have long influenced the curriculum and teaching of mathematics and continued to for these girls. This resulted in their disengagement from this valuable school subject. The research questions were addressed in three findings chapters where the contrasts between the girls’ experiences of mathematics and their experiences of their other school subjects were clearly shown. The key themes generated from the data were analysed in the three findings chapters.

Summary of Findings

Mathematics is one of the essential areas of learning in the New Zealand Curriculum Framework (Ministry of Education, 2007). The girls in this research were in Year Twelve and were all undertaking a range of courses at NCEA level two. Four different year twelve mathematics classes were observed at least four times each in this research. The girls were also observed forty-two times in their other school subjects. Twenty-two interviews were conducted and then transcribed. I found reference to the following key themes: experiences of the space in classrooms and mathematical pedagogies including collaboration, discussion and practical experiences; the practical uses of school mathematics for the participants; perceived present and future usefulness of the mathematics taught at school; discourses around assessment practices and credit accumulation in schools; the emotional impact of studying mathematics at school and how these experiences of school mathematics resulted in dislike and withdrawal from mathematics in the future.

The classroom practices in mathematics were for the most part identical across the four classrooms visited. The teacher was the authority in the classroom and teaching was based around rituals such as ten-question starters, teacher-directed instruction, worksheets and exercises from textbooks. Noise levels were often quite high and much of the classroom discussion was off-task, not related to the teaching and learning expected by the classroom teacher. The teachers spent much of their time directing students to stay on-task rather than working with them to check learning and understanding. Many of the girls described their mathematics classrooms as noisy and complained that sometimes the teacher failed them by not keeper tighter controls on others. However, most of the girls liked their teachers and were more likely to blame themselves for any failures in mathematics rather than blame their
teachers. There was often a strong discourse around the idea that if they listened more or worked harder then mathematics may have been easier and their results may have improved.

The girls rarely worked on their mathematics in groups and rarely were their any full-class discussions related to contextual mathematical knowledge. Many of the girls discussed the procedural approach in terms of mathematics classes always being the same every day and had come to see this as the norm. For a few, they appreciated it as this gave them the notes and examples that they felt would help them to prepare for assessments. However, often their higher-level thinking skills were not developed and when confronted with the harder merit or excellence questions they struggled and this resulted in feelings that mathematics was too hard or difficult for them. There appeared to be this feeling that in class the girls could do the skills-based tasks but when asked to apply the skills to a new, unknown situation they were unable to make the links required.

Mathematics also evoked a range of negative emotions from many girls as they struggled to see its worth. Many of the girls hated mathematics, they viewed it as unimportant and boring, and they enjoyed their other school subjects far more. In contrast, other subjects are often described using positive adjectives such as fun, enjoyable and creative. Hegemonic traditions and masculinised methods of teaching and learning were apparent in all of the mathematics classrooms. The rules and routines of these classrooms and the teacher directing all learning positioned the teacher as the all knowing disseminator of knowledge and the person always in control of the students’ learning. Traditional teaching methods continued to influence the curriculum and teaching of mathematics for these girls, and resulted in their disengagement from this important school subject.

Mathematical spaces were experienced in various contrasting ways to the spaces provided in other school subjects. The research findings identified that traditional pedagogies that involved teacher-directed classroom spaces dominated their experiences of mathematics. There was very little opportunity for discussion and group work in mathematics. In contrast to mathematics, the girls experienced more student-directed learning in their other subjects. The girls were able to move freely around the rooms in other subjects; they were able to control their own learning progression by having freedom to construct their own knowledge production in collaboration with others by discussing their work with both the teacher and their peers. Rarely in mathematics did the girls experience practical, hands-on activities, and rarely did they see any practical uses for the mathematical skills they were being taught. Realistic contexts were missing and they found it difficult to link mathematical ideas to real-world experiences. Discourses surrounding assessment and the credits required within the
qualification framework appeared throughout the data. Often the pedagogical experiences of the girls were closely related to the consequences of an assessment-driven curriculum.

Tensions arose because mathematics was often sold to these girls as something useful for their futures, however, their experiences left them confused about this usefulness. These negative experiences of mathematics influenced whether these girls chose to continue with mathematics in the future. This research showed that the girls preferred their other subjects and subject teachers to mathematics and their mathematics teachers, often describing their other subjects as more engaging, more useful and more thought provoking. Only three of my research participants wanted to continue with mathematics in the year following from this study. For the other eleven disengaged girls, their other school subjects provided them with more appealing pathways for learning and because of this their mathematical journey ended. The learning of mathematics is far too important to be discarded in this way.

Contribution to Knowledge

The examination of girls’ experiences in their other school subjects has provided an interesting insight into how the spaces provided and utilised in classrooms can impact on the enjoyment and engagement of a subject at school. What this research has shown is not so much everything that was wrong in mathematics for these girls, but more what was right about their other subjects.

The thread that weaves through the stories of each of the research participants is that they did not enjoy school mathematics and they preferred their other subjects more. This study provides details about how these girls engaged in their school subjects and which aspects of the learning processes and organisation of classroom spaces suited their style of learning.

Project-type work based around a task, which allowed them room to be creative and original, were aspects of other subjects the girls enjoyed. They liked working together in groups, collaborating with ideas. They enjoyed discussions with their teachers and with each other. The girls also liked open working spaces such as they found in technology, art and drama teaching spaces. Moving around the classroom to see what others were doing and to engage with the teacher made them feel comfortable.

These findings contribute to our knowledge of what these girls saw as comfortable working spaces and how this influenced their enjoyment of a subject. Mathematics teachers who still teach girls in the more traditional teacher-led environments may find it useful to visit classrooms of subjects they are not as familiar with to see what they could alter in their own
classrooms. This could start back in pre-service teacher education, where trainees could be encouraged to experience the classrooms of practitioners identified to be using different pedagogies that have shown to engage leaners, especially girls. Pedagogical spaces were shown in this research to impact on learners’ experiences and this aspect of teaching requires more emphasis in pre-service, and in-service teacher education. The gendering of spaces in schools continues and is worthy of instruction to examine how aspects impact on particular groups of learners in schools.

**Implications**

Although my data may be considered my some to be dated because of when it was collected, it still contributes much to our thinking about how girls experience school mathematics today. Many of the same themes identified in the literature (see chapter three) appeared in this research indicating that all is still not well in mathematics for many girls. Many of the negative emotions raised by some of the girls in this study are similar to previous and current gender research in mathematics. However, what differs in this study are two other aspects: how the NCEA qualification framework raised issues about pedagogical practices in the girls’ mathematics courses, and how these girls were able to identify the positive aspects of spaces offered to them in their other school subjects. The girls in this study shared their experiences from their more ‘feminine’ school subjects and contrasted these in terms of their emotional engagement with school mathematics. The implications of this research have been very personal for me, as a mathematics teacher, as this research affirmed that my own pedagogical practices (as well as many of my peers in mathematics classrooms) needed to change and, as a consequence, my classroom practice has altered considerably since undertaking this research. I am now the Head of Department of the mathematics and statistics learning area in a New Zealand secondary school, teaching from Years Seven to Thirteen, and with the added role of numeracy leader as well.

From the first day I began in this teaching position I have set a personal goal of ensuring that the girls I teach leave my classroom without saying: “I hate maths”. This may seem a simplistic goal, however, I continue to find that the girls I teach arrive in my classes at the beginning of each year with a range of emotions about their previous experiences of mathematics whether that be from a previous primary school, a previous teacher, or as a result of the pressures of the NCEA assessment regime.

I believe that I need to model what I have learned from this research study. My classroom has the desks organised in groups of four to six. Some of my classes are quite big
and I am constrained by the space of my small classroom to be more creative with the placement of furniture in the space. The focus in the desk spaces is on the students working together to construct their own learning. I rarely teach from the front of the classroom and only use my whiteboard to record learning and discussions when a need arises.

My junior classes (Years Seven to Ten) learn mathematics through investigations and projects. I find enriching tasks and present these as open-ended briefs. I require my students to collaborate on the tasks in their groups and to share ideas. I have even taken to removing the need to read out answers, instead getting the students to look at each other’s work and see where there are differences. From there, they negotiate around who might have the best answer and teach each other how they came to find that answer.

My unit plans are now more thematic. Instead of doing a unit on, for example, algebra in Year Seven, I have called it “Patterns in Aotearoa” and linked the teaching around cultural aspects of patterns bringing in links to other strands such as measurement and geometry. I have developed ideas around patterns by using material that they play with such as cubes, toothpicks, foam shapes, counters, grids, isometric paper, dominoes and so on. The students often sit in groups on the floor and spend time making examples of patterns, considering what they have to change each time and how this is linked to their descriptions of the patterns and the finding of a rule.

Projects are worked on in class. There is plenty of time to ask questions, to discuss progress with peers and to identify issues. Work done at home focuses on the finishing not the doing. I want their best work at all times so I adjust my programmes to fit the tasks not to rush through every aspect of detail in the curriculum. The learning has become much more holistic and my achievement results have improved.

The students appear happy, they appear to enjoy the change in how mathematics is learnt in my classroom, and they feel confident to provide me with constructive feedback on what they liked and did not like and why. I am learning about what they can do and their understandings through rich discussions in the classroom. The need to test regularly has become unnecessary and this has alleviated much of the associated stress around constant assessment as in the past.

Examination classes (Year Eleven to Thirteen) are more constrained by the NCEA regime, but I have still been able to encourage more collaboration on tasks and instead of traditional note-taking and worksheets, I am using more task orientated learning where the teaching focuses on problems as they arise in a particular task. This has allowed for better engagement in class and for elevated levels of enjoyment.
I see my role as a Head of Department to model how my staff could change their pedagogical approaches across our mathematical teaching. We have regular professional development and sharing of activities, tasks, and teaching methods that have worked well to provide engaged classes. Our aim is to improve our teaching and learning first and the results so far suggest that achievement levels for our girls are rising, but more importantly our retention rates through to the final year of schooling are very high in mathematics. It is rare for students at our school to drop mathematics in Year Thirteen. They value mathematics and believe that they can do mathematics at this high level.

I hope that my sharing of my research findings in the wider mathematical communities in New Zealand will show other teachers how a few pedagogical changes can improve the experiences of girls in their classrooms. I have presented at local, national and international conferences and will continue to do so. In July 2015, I am running a workshop called “We teach girls” in conjunction with a school colleague. We hope to show the strong links between my research and the changes we have made in our teaching practice.

While it is great that my own practices have been reshaped as a result of this research, and that I am able to share my research and experiences with many colleagues, this research has wider implications for mathematics researchers, educators and practitioners. It is vital that the Ministry of Education and NZQA recognise that although many girls have shown they are capable mathematicians with improved success in assessments, they nevertheless do not enjoy mathematics and this is particularly obstructed by the present NCEA assessment regime.

Compartmentalising mathematics into bite-size achievement standards does not allow all students to see the links between the content in each standard and, more importantly, how the mathematics is used in wider society. Mathematical insight and higher-level thinking (required at Excellence level in NCEA), in my opinion, is closely linked to students being able to see how the skills relate to contextual situations. At present, the way mathematics is taught in discrete fragments disregards the importance of experimenting and playing around with problems to extend mathematical thinking and generate new ideas that lead to producing further knowledge discoveries. I believe that NCEA stifles mathematical creativity and directs our learners to passively receive and regurgitate known facts and skills to answer assessment criteria only. This has serious implications if we believe that our society is in need of mathematically literate citizens able to engage in STEM industries that require technological skills beyond what is presently taught at schools. All of our students deserve every opportunity to participate in these new career directions in the future.
Limitations of the Research

The findings of this study are subject to some important limitations. The main study was done in an urban school where the girls may not have been representative of the wider population of New Zealand. Differences in ethnicity and socioeconomic background were not a focus of this study. New Zealand has a diverse ethnic make-up and it would have been interesting to focus on the experiences of different groups of girls based on their ethnicity. Māori and Pasifika students are considered priority learners in the New Zealand educational context so the specific needs of girls belonging to these groups would have added value to this study. Unfortunately, my group of research participants did not include any girls who identified as Māori or Pasifika.

The study did not take into account the socioeconomic backgrounds of the research participants. Low decile schools have students from lower socioeconomic backgrounds than higher decile schools (Ministry of Education, 2015b). This research was conducted in two schools only and did not take into account the socioeconomic backgrounds of the participants. Further research that acknowledges the backgrounds of participants including more in-depth knowledge of their home backgrounds may provide some interesting insights.

As previously mentioned, the research participants were all Year Twelve. The findings confirmed that many of the girls had strong opinions about mathematics by Year Twelve. This was not a longitudinal study and I believe it would be interesting to follow some girls over a longer period of time as they transition from primary to intermediate to secondary, interviewing at different transitional stages to try and identify how their experiences throughout their schooling impact on their relationship with school mathematics.

At the time of this research, the data collection methods were somewhat clumsy. Many of the issues with recording onto audiotapes would now, in 2015, be eliminated through the use of the modern digital technologies available. Video recordings may have provided me with more data related to facial expressions, hand movements and other indicators of emotions. The use of blogs and social media, such as Facebook or Instagram, would be useful tools to use with teenage participants who appear comfortable using such tools to express their emotions and feelings.

Future research directions could include following a selection of my present students where I have implemented changes by using different pedagogies within my teaching. Interviewing students at the beginning of Year Seven and then at various stages, possibly at the end of each school year through to Year Thirteen could provide rich longitudinal data from middle school, pre-NCEA, through their senior examination years until they finish
school. This further research could look at where these students end up in their mathematical studies and how their attitudes change over their time at school.

Another area not widely researched in New Zealand, is the impact of peer and parental influence on mathematical experiences. Mention of these influences was made by some girls in their interviews, but was beyond the scope of this study. These references to what their peers or parents said about mathematics appeared in some transcripts and left many unanswered questions that require further unpacking such as: Do girls continue to study mathematics when their peers opt out? and, When parents have negative attitudes and experiences of their own mathematics studies at school, does this impact on how girls approach their own mathematics courses?

Advances in technology have increased exponentially since this research was undertaken. My present school is a laptop school with every girl required to purchase a MacBook Air/Pro at the beginning of Year Seven. The impact of digital learning technologies on girls’ experiences and engagement levels in mathematics would be another interesting research area to examine in detail. Two future research domains could be: How do digital literacies impact in mathematics’ classrooms? and, Do girls experience mathematics differently when there is access to online teaching resources in their classrooms and at home? A follow-up to this would be investigating how girls in less well-resourced schools could be engaged through more government funded digital technologies and resources, as many schools struggle to provide tools more widely used in higher decile schools, suggesting that resource inequities could be a present and future handicap for many leaners in New Zealand schools.

Looking to the Future

The challenges for mathematics teachers who teach girls are many. Teachers need to work within the many constraints of a school environment and assessment regime that influences everyday practice and at the same time aim to engage learners and encourage them to see the usefulness of the mathematics they teach.

In most cases, girls can do mathematics as well as boys, but far too many opt out because they do not enjoy mathematics and see no relevance for them personally for their futures. Mathematics is still placed highly on the hierarchy of subjects deemed important for entry to many courses and careers. The gateways need to remain open for all girls to be able to enter the STEM fields, in particular, which are still male-dominated professions.
As a woman, a mother, and a mathematics teacher it saddens me that many girls still struggle to have positive experiences in school mathematics. We need to listen to the girls who continue to tell us that they ‘hate maths’ and work together (schools and families) to examine our practices, our classrooms spaces, our assessment procedures and how we talk in everyday conversations about mathematics in general. If we can alter the experiences and perceptions of this present generation of girls we could, in the future, stop all the stories about what was wrong with school mathematics and instead have girls/women talk with affection about how great mathematics was at school and how what they learned was interesting, useful, and worthwhile. They could say: “I loved maths at school”.
REFERENCES


Davies, B., & Davies, C. (2007). Having, and being had by, "experience" Or, "experience" in the social sciences after the discursive/poststructuralist turn. *Qualitative Inquiry, 13*(8), 1139-1159.


APPENDIX A: ETHICS COMMITTEE APPROVAL LETTER

28 April 2004

Professor D Holton
Department of Mathematics & Statistics
Division of Sciences

Dear Professor Holton

I am writing to let you know that the Ethics Committee has now considered under the ‘Fast-Track’ provisions your proposal entitled “Mathematics as a secondary subject: A girl’s view”.

As a result of that consideration, the current status of your proposal is:- Approved

For your future reference, the Ethics Committee’s reference code for this project is:- F04/004.

Yours sincerely,

Mr G K (Gary) Witte
Manager, Academic Committees
Tel. 479-8256
Email: gary.witte@stonebow.otago.ac.nz

c.c. Assoc. Prof. P Fenton Head Department of Mathematics & Statistics
APPENDIX B: INFORMATION SHEET AND CONSENT FORM FOR STUDENT

Application Form for ethical consideration of research and teaching proposals involving human participants

Mathematics as a secondary subject: A girl’s view.

INFORMATION SHEET FOR STUDENTS

I am Fiona Hogan from the University of Otago and currently I am conducting a research study in Mathematics Education for my PhD thesis. This project is on girls and mathematics and looks at how girls perceive mathematics compared to their other secondary school subjects. The findings will have relevance for all mathematics educators.

I would like to invite female students in Year 12 mathematics classes to participate in this study. The first part of the study will involve observations and audio taping of the participants in their mathematics class as well as in two other curriculum areas such as English and Text and Information Management. The students will be required to wear a small microphone in class to enable the researcher to collect data during the regular classroom environment. Stage two involves an audio taped interview with the students closely following the classroom observations. Where possible the interview will take about one hour and will be conducted at a time that will not cause interruption to their regular classes, such as a study period or at lunchtime.

To assist you in your decision, please be aware that any information recorded on the tape as part of this investigation will remain confidential to the researcher. Data will be made available to you on completion of the study or, if you wish, will be disposed of after five years.

Participation is entirely voluntary. If you do participate you will have the right to:

- Withdraw from the study at any time.
- Ask any questions about the study at any time during the research process.
- Provide information on the understanding that your name will not be used and that the school will not be identified in any material produced from this study.
- Access a summary of the finished report when the study is concluded.

This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. Consequently, although the University of Otago Human Ethics Committee is aware of the general areas to be explored in the interview, the Committee has not been able to review the precise questions to be used.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and
Application Form for ethical consideration of research and teaching proposals involving human participants

also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

I will be pleased to answer any queries about the research that you might have. If you wish to have any further information please contact my PhD supervisor, Professor Derek Holton or myself.

Fiona Hagan or Professor Derek Holton
Department of Mathematics and Statistics Department of Mathematics and Statistics
Ph: 479 7758 Ph: 479 7758
Email: fhagan@maths.otago.ac.nz Email: dholton@maths.otago.ac.nz

This project has been reviewed and approved by the University of Otago Human Ethics Committee
Mathematics as a secondary subject: A girl’s view.

CONSENT FORM FOR STUDENTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. The data audiotapes will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed;

4. This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular questions and/or may withdraw from the project without any disadvantage of any kind;

5. The results of the project may be published and will be made available but every attempt will be made to preserve my anonymity.

I agree to take part in this project.

...............................................................  ..................................................
(Signature of participant)  (Date)

This project has been reviewed and approved by the University of Otago Human Ethics Committee
APPENDIX C: INFORMATION SHEET
AND CONSENT FORM FOR PARENTS

Application Form for ethical consideration of research and teaching proposals involving human participants

Mathematics as a secondary subject: A girl’s view.

INFORMATION SHEET FOR
PARENTS / GUARDIANS

I am Fiona Hagan from the University of Otago and currently I am conducting a research study in Mathematics Education for my PhD thesis. This project is on girls and mathematics and looks at how girls perceive mathematics compared to their other secondary school subjects. The findings will have relevance for all mathematics educators.

I would like to invite female students in Year 12 mathematics classes to participate in this study. The first part of the study will involve observations and audio taping of the participants in their mathematics class as well as in two other curriculum areas such as English and Text and Information Management. The student will be required to wear a small microphone in class to enable the researcher to collect data during the regular classroom environment. Stage two involves an audio taped interview with the student closely following the classroom observations. Where possible the interview will take about one hour and will be conducted at a time that will not cause interruption to their regular classes, such as a study period or at lunchtime.

To assist you in your decision, please be aware that any information recorded on the tape as part of this investigation will remain confidential to the researcher. Data will be made available to you on completion of the study or, if you wish, will be disposed of after five years.

Participation is entirely voluntary. If you do participate you will have the right to:

- Withdraw from the study at any time.
- Ask any questions about the study at any time during the research process.
- Provide information on the understanding that your name will not be used and that the school will not be identified in any material produced from this study.
- Access a summary of the finished report when the study is concluded.

This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. Consequently, although the University of Otago Human Ethics Committee is aware of the general areas to be explored in the interview, the Committee has not been able to review the precise questions to be used.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and
Application Form for ethical consideration of research and teaching proposals involving human participants

also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

I will be pleased to answer any queries about the research that you might have. If you wish to have any further information please contact my PhD supervisor, Professor Derek Holton or myself.

Fiona Hagan or Professor Derek Holton
Department of Mathematics and Statistics Department of Mathematics and Statistics
Ph: 479 7758 Ph: 479 7758
Email: fhagan@maths.otago.ac.nz Email: dholton@maths.otago.ac.nz

This project has been reviewed and approved by the University of Otago Human Ethics Committee
Mathematics as a secondary subject: A girl’s view.

CONSENT FORM FOR PARENTS/GUARDIANS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My daughter’s participation in the project is entirely voluntary;

2. She is free to withdraw from the project at any time without any disadvantage;

3. The data audiotapes will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed;

4. This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that she feels hesitant or uncomfortable she may decline to answer any particular questions and/or may withdraw from the project without any disadvantage of any kind;

5. The results of the project may be published and will be made available but every attempt will be made to preserve my anonymity.

I agree to my daughter taking part in this project.

......................................................... ........................................
(Signature of parent/guardian) (Date)

This project has been reviewed and approved by the University of Otago Human Ethics Committee
APPENDIX D: INFORMATION SHEET
AND CONSENT FORM FOR PRINCIPALS/HEADS OF
DEPARTMENTS/CLASSROOM TEACHERS

Application Form for ethical consideration of research and teaching proposals involving human participants

UNIVERSITY
OTAGO

Mathematics as a secondary subject: A girl’s view.

INFORMATION SHEET FOR PRINCIPALS/HEADS OF
DEPARTMENTS/CLASSROOM TEACHERS.

I am Fiona Hagan from the University of Otago and currently I am conducting a research study in Mathematics Education for my PhD thesis. This project is on girls and mathematics and looks at how girls perceive mathematics compared to their other secondary school subjects. The findings will have relevance for all mathematics educators.

I would like to invite female students in Year 12 mathematics classes to participate in this study. The first part of the study will involve observations and audio taping of the participants in their mathematics class as well as in two other curriculum areas such as English and Text and Information Management. The student will be required to wear a small microphone in class to enable the researcher to collect data during the regular classroom environment. Stage two involves an audio taped interview with the student closely following the classroom observations. Where possible the interview will take about one hour and will be conducted at a time that will not cause interruption to their regular classes, such as a study period or at lunchtime.

To assist you in your decision, please be aware that any information recorded on the tape as part of this investigation will remain confidential to the researcher. Data will be made available to you on completion of the study or, if you wish, will be disposed of after five years.

Participation is entirely voluntary. If you do participate you will have the right to:

- Withdraw from the study at any time.
- Ask any questions about the study at any time during the research process.
- Provide information on the understanding that your name will not be used and that the school will not be identified in any material produced from this study.
- Access a summary of the finished report when the study is concluded.

This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. Consequently, although the University of Otago Human Ethics Committee is aware of the general areas to be explored in the interview, the Committee has not been able to review the precise questions to be used.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and
Application Form for ethical consideration of research and teaching proposals involving human participants

also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

I will be pleased to answer any queries about the research that you might have. If you wish to have any further information please contact my PhD supervisor, Professor Derek Holton or myself.

Fiona Hagan or Professor Derek Holton
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This project has been reviewed and approved by the University of Otago Human Ethics Committee
Mathematics as a secondary subject: A girl’s view.

CONSENT FORM FOR SCHOOLS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. The data audiotapes will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed;

4. This project involves an open-questioning technique where the precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular questions and/or may withdraw from the project without any disadvantage of any kind.

5. The results of the project may be published and will be made available but every attempt will be made to preserve my anonymity.

I agree to my school taking part in this project and to Fiona Hagan contacting any Heads of Departments as required for this project.

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(Signature of Principal)                                      (Date)

This project has been reviewed and approved by the University of Otago Human Ethics Committee

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