

An exploration of the ways in which secondary school girls construct their
relationship with Mathematics and Mathematical Literacy

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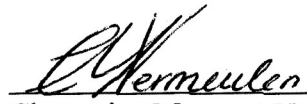
My family, thank you all for your support, prayers and encouragement every step of the way.

DEDICATION

This thesis is dedicated to my dad who passed away before seeing me achieve everything he knew I was capable of achieving

DECLARATION OF ORIGINALITY

I hereby declare that this dissertation is my own work, and that all sources consulted and quoted have been indicated and acknowledged by means of complete references.


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ABSTRACT

This study explores the ways in which Grade 11 girls from an independent, predominantly middle to upper middle-class Catholic school construct their relationship to Mathematics. The study illustrates how doing Mathematics is doing gender and sexuality and furthermore how the association with Mathematics underpins identity work as the category “girl” is lived out amongst sixteen and seventeen year old white and Indian South Africa girls. The girls in this study associate with two kinds of Mathematics, that of Core Mathematics and Mathematical Literacy and it is argued that they relate to Mathematics in terms of the hierarchies and power vested in each. By drawing upon the stories of the girls in these two different learning areas of Mathematics the study shows how they actively negotiate, use and strategise around Mathematics. The girls who take Core Mathematics as a subject use the masculine power of Mathematics as proof of real intelligence to inscribe and claim power over other girls and boys. On the other hand, although girls who take Mathematical Literacy as a subject, rejected Core Mathematics and showed enjoyment of Mathematical Literacy, insert themselves in a subordinate way to the Core Mathematics girls. Further to this, the study shows how girls construct their sexuality in relation to Mathematics where Mathematics and its association with economic and social capital is also perceived as sexual capital. What this study shows is that when each of the girls in this study relates to Mathematics, she does not relate to the learning area of Core Mathematics or Mathematical Literacy alone, but her relationship to Mathematics is embedded with social processes including sexuality, gender, race, class and age and these are actively acted upon. South Africa has made it a priority to focus on improving the participation and performance of the majority of learners, particularly girl learners, in the areas of Mathematics and Science. The White Paper on Education calls for “an appropriate Mathematics, Science and Technology education essential to stem the waste of talent and make up the chronic national deficit in these fields of learning which are crucial to human understanding and to economic development” (Department of Education, 1995, p. 26). Assuming that Core Mathematics and Mathematical Literacy can provide girls with equal chances to succeed is, as this study shows, simplistic.

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CHAPTER 1 INTRODUCTION TO THE STUDY

1.1. INTRODUCTION

This research explores the ways in which Grade 11 girls from an independent, predominantly middle to upper middle-class Catholic school construct their relationship to Mathematics. By drawing upon qualitative and feminist methodological approaches, this study explores the meaning that 16 and 17 year old girls give to Mathematics. Further to this, this study explores the construction of girls' identities as key in understanding the various processes through which they develop a sense of who they are in relation to Mathematics and Mathematical Literacy. There is little qualitative research in the Mathematics education literature that informs "the evidential facts that girls choose Mathematics less than boys and that gender disparities in achievement prevail at some levels"(Boaler, 2000, p. 39) and even less research that approaches this through an exploration of the identities of learners doing Mathematics.

This study is not about achievement, but rather focuses on the construction of girls' identities in relation to Mathematics and illustrates how doing Mathematics is doing gender. Furthermore how the association with Mathematics underpins identity work will be examined as the category 'girls' is lived out amongst sixteen and seventeen year olds. It also illuminates how sexuality is embedded within the doing of gender and how doing Mathematics is not only doing gender but sexuality as well. When each of the girls in this study relate to Mathematics they do not relate to the learning area of Mathematics or Mathematical Literacy alone, but their relationship to Mathematics is embedded within social processes including sexuality, gender, race, class and these are actively acted upon.

This thesis argues that the discourses that are most central to Mathematics, construct it as 'hard', 'absolute', 'a proof of real intelligence', 'certain' and 'objective'. These discourses are oppositional and gendered. They inscribe Mathematics as masculine and make it difficult for girls to form a positive association with it.

What this thesis will show is that the girls in this study associate with two kinds of Mathematics: Core Mathematics¹ and Mathematical Literacy and it is further argued that they relate to Mathematics in terms of the hierarchies and power vested in each. The girls in this study do not simply reproduce the idea that Mathematics is masculine, but they work on this. The Core Mathematics girls use it to their advantage and craft out power for themselves. The Mathematical Literacy girls, although they rejected Core Mathematics, spoke about enjoying Mathematical Literacy. However, Mathematical Literacy has been constructed as ‘easy and soft’ Mathematics and as a result has been relegated to a position of inferiority. Other girls and teachers reinforce this position, and the Mathematical Literacy girls inscribe within this.

In South Africa, the imperative to improve women and girls involvement in Mathematics and Science in school is increasing. Mthiyane (2007) documents that the number of girl learners who have access to schooling and to subjects like Mathematics and Science in South Africa is high when compared to most African countries. Statistics show that girls’ performances in Mathematics has improved substantially, with both the number of female candidates participating growing at a faster rate than male candidates, and the gender gap in pass rates decreasing. The 2003 Senior Certificate Examination results presented in Table 1.1 below show that in terms of gender, 4, 3% of female candidates pass higher grade Mathematics compared with 5, 8% of male candidates. There are disparities in the performance of girls as well with only 1.1% and 3.3% of African and Coloured females respectively passing HG Mathematics compared with 20, 3% and 22, 9% of Indian and White females.

¹ The use of the term “Core Mathematics” and “Mathematical Literacy” are derived from their use by the learners from this particular school.

Table 1.1. Mathematics HG passes as a percentage of all candidates writing the Senior Certificate Examination by race and gender, 2003.

Race	Gender	Total candidates	HG maths pass	HG maths pass as a % of population writing SCE.
African	F	186 053	2 065	1. 1%
	M	155 328	3 813	2. 5%
	Total	341 381	5 878	1. 7%
Coloured	F	17 915	591	3. 3%
	M	13 912	586	4. 2%
	Total	31 827	1 177	3. 7%
Indian	F	8 702	1 763	20. 3%
	M	7 315	1 636	22. 4%
	Total	16 017	3 399	21. 2%
White	F	23 366	5 354	22. 9%
	M	22 479	5 401	24. 0%
	Total	45 846	10 755	23. 5%
Unknown	F	2 412	360	14. 9%
	M	1 981	249	12. 6%
	Total	4 393	609	13. 9%
Total	F	238 448	10 133	4. 3%
	M	201 015	11 686	5. 8%
	Total	439 463	21 818	5. 0%

Source: SCE database cited in Edusource No48/April cited in Mthiyane (2007, p.5)

Although statistics show that boys still dominate Mathematics in terms of performance, the gap is closing. KZN Education Department Superintendent-General Cassius Lubisi (Mchunu, 2006) reported that this gap would probably be completely closed by 2008. This increase in performance and participation, however, needs to be seen against the background of a precipitous decrease in the number of female candidates entering for the HG Mathematics examination. The number of entries fell from 30 646 in 1996 to 16 598 in 2002. Perry & Fleisch (2006) argue that one of the explanations for this is that schools are actively discouraging female learners from enrolling for HG Mathematics to ensure higher average school pass rates.

Despite the recent trends and developments into the fields of Mathematics and Science here in South Africa, very little has changed regarding the number of women and girls who chose to study further in these lucrative fields. The participation of girls in the fields of Mathematics and Science post matric remains particularly low. Statistics are unable to provide us

with the finer nuanced ways on understanding how girls interpret Mathematics, incorporate it into their lives and why so many girls reject it, dissociate from it and have negative feelings towards it. This thesis however, seeks to explain what meanings these schoolgirls attach to Mathematics and in the process how they interpret Mathematics in the construction of their identities. Unless we are able to understand why the identities of so many girls preclude that of Mathematician and Scientist, we will be unable to stem the tide of wasted talent in these areas.

The problem of the under-representation of girls in Mathematics is not specific to South Africa, but has been well documented in international literature as well. Paechter (2001a) argues that girls' enjoyment of and engagement with Mathematics does not seem to have increased with academic success. In contrast to the changing patterns in achievement, the decision to continue with Mathematics after matric remains highly gendered. Mendick (2005b) argues that the evolving gendered patterns in achievement in Mathematics need to be juxtaposed with the unchanging gendered patterns of participation in the subject.

Reason and rational thought are central aspects of the socially constructed image of Mathematics and according to Paechter (2001a), reason and rationality have been defined in exclusively masculine terms since the Enlightenment Period. This will be discussed in more detail under the section on the gendered nature of Mathematics later in this chapter. Owing to its rational construction, Mathematics has become associated with masculinity. Drawing from this, I argue that the discourses that are most central to Mathematics construct it as 'hard', 'absolute', 'abstract', 'a proof of intelligence', 'certain' and 'objective' and that these discourses inscribe Mathematics as masculine (Bhana, 2005; Mendick, 2004). These discourses variously frame Mathematics, as a key skill, a source of knowledge necessary for the successful negotiation of life in a scientifically and technologically sophisticated society, and thus as a source of personal and economic power (Mendick, 2002a). And that "unless [girls] incorporate Mathematics positively into their identity work, then compulsory Mathematics will remain largely unsuccessful in getting them to [participate in it], enjoy it and achieve" (Mendick, 2004, p. 207).

Having discussed the need to explore the rationale for this study, it now becomes necessary to focus on the gendered nature of Mathematics as one of the central aspects of this thesis.

1.2. THE GENDERED NATURE OF MATHEMATICS

The socially constructed image of mathematics as ‘hard’, ‘absolute’, ‘abstract’, ‘certain’ and ‘masculine’, which is not unproblematic in itself, can best be used to explain the under-representation of girls in Mathematics. The gendered nature of Mathematics can be viewed in terms of the biological differences between girls and boys, the socially constructed image of Mathematics and the attitudes, beliefs and ideas that the girls themselves have of Mathematics. Biological differences between boys and girls have a long history of being used to exclude women from education (Mendick, 2004). Mendick (2006) shows that research on gender similarities and differences state that there is no physical or intellectual barrier to the participation of women in Mathematics. It is becoming accepted that women have and continue to be under-represented in the field, mainly because of social and cultural barriers. Interestingly, current research into the under-representation of boys in Mathematics today relative to girls does not seem to have given rise to biological explanations similar to those used for girls. Researchers have tended to invoke social influences as reasons for change.

Reason and rational thought are central aspects of the socially constructed image of Mathematics and Paechter (2001a) writes that ideas about reason and rationality cannot be understood historically outside considerations of gender. “Since the Enlightenment Period, if not before, the Cartesian concept of reason has been deeply embroiled with attempts to control nature” (2001a, p.14). Enlightenment turned its scientific gaze on the human body, being female, and produced a ‘truth about women’s nature being outside of rationality’. Mendick (2004, p.213) argues that “since the gendered body was the basis for explaining the mind, gender is internal to, and productive of, the means by which we understand reason”.

Both Paechter (2001a) and Mendick (2004) see the socio-cultural discourses that shape the nature of Mathematics, as being oppositional and gendered. They inscribe Mathematics as masculine, making it more difficult for girls to feel talented at and comfortable with Mathematics and as a result, choose it and do well at it. Walkerdine (1998) vehemently argues that gender differences have much to do with a myth regarding male superiority in Mathematics. However, the myth is so embedded within, and colours the views of society, that it has come to be perceived as true.

Mendick (2004, 2005a, 2005b, 2006) has made significant contributions to understanding gender and mathematics education. She writes that it is not what Mathematics is or is not that matters, but what it is constructed as being and not being. The stories we tell about Mathematics, the discourses through which it is constituted, and the subject positions that these make available to learners, the ways in which Mathematics becomes part of identity. Conceptualising doing Mathematics as doing masculinity (Bhana, 2005; Mendick, 2004) is a productive way of understanding why Mathematics is so male dominated, and illuminates the implications that this has for gender and Mathematics work. “When Mathematics is located as challenge-seeking oriented towards mastery as proof of knowledge and as masculine, they have inequitable effects” (Bhana, 2005, p.8). If girls are to fulfil their potential in Mathematics then the image of Mathematics, how it is taught and how to ensure that all children get a fair chance must be addressed. If we as teachers, curriculum designers, educational policy makers and politicians here in South Africa wish to see all girls fulfilling their potential in Mathematics, which is acknowledged as a critical filter controlling entry into high status areas of academia and the labour market, then we need to give them an opportunity to tell their Mathematical stories.

In the next section I tell my own stories regarding the various ways that I gave meaning to, and still give meaning to myself whilst engaging with Mathematics. These stories are important as they highlight my relationship with Mathematics and the interest I have in exploring, understanding and thinking about gender and Mathematics. Although this thesis is not autobiographical, it is important that, in order to understand my identification with subject of Mathematics, you know a little about me. Mendick (2004, p.

8) argues that “given the powerful feminist arguments for the necessity of interrogating one’s own identity in producing reflexive explorations of practice”, I am obliged to include my narratives on self in my work. Drawing on feminist writings on methodology, which I explore in more detail in Chapter 3, it is clear that every researcher is present in their work.

1.3. ‘MATHEMATICS AND I’ – A PERSONAL REFLECTION

“He loves me, he loves me not”

In reflecting on my own relationship with Mathematics, my thoughts are drawn back to a game I used to play as a young girl. In this game, I would naively attempt to ascertain whether the boy I liked, liked me in return by pulling off the petals of a flower one by one while simultaneously chanting “he loves me, he loves me not”. Although absurd, it appears to me that my relationship with Mathematics could be summarized as a romantic interlude complete with its own concomitant emotional rollercoaster. This view of my relationship with Mathematics best describes my attraction to the subject as a Mathematics pupil², a Mathematics teacher and novice gender and Mathematics researcher.

1.3.1. Identities, labels and choices

Mendick (2006) believes that identity may be a fiction but it is clearly an important one. She elaborates that, “...people construct narratives of self by taking on labels. The perspective of situated cognition suggests a close relationship between this process and learning” (Mendick, 2004 p.8). Situated cognition theories regard learning as a social practice, and within this framework learning happens in a manner similar to an apprenticeship, via legitimate peripheral participation in a community of practice (Bartholomew, 2002b; Boaler, William, & Zevenbergen, 2000; Cotton, 2002; Mendick, 2004). This community of practice may be that of Mathematics pupils, teachers and Mathematicians and the learner becomes formally and informally introduced into the community. Thus, according to

2. I refer to myself as a pupil here and then later refer to the students at Glenville College and the participants in this study as learners, this is done intentionally. When I attended school we were referred to as pupils, but with the introduction of C2005 the term ‘pupil’ has been replaced with the more democratic term ‘learner’.

Lave & Wenger (1991 cited in Lerman, 2000, p. 115) “learning and a sense of identity are inseparable”.

I have organized my personal reflections below around labels that are important to me, and have in one way or another contributed to the development of my relationship with Mathematics.

1.3.2. Charmaine – The mathematics pupil

For as long as I can remember I have always enjoyed Mathematics. Reflecting back on my school reports, it was one of my stronger subjects throughout Primary and High School. I found it particularly interesting that while all the comments alongside my Mathematics results labelled me as a hardworking pupil, not one teacher made reference to me having a natural ability or Mathematical aptitude. As a subject, I found Mathematics to be extremely interesting, stimulating, challenging and enjoyable. As a schoolgirl, my desire to excel in Mathematics was influenced by two factors.

Firstly, growing up I battled terribly with a weight problem and lived for the better part of my childhood and teenage years in the shadow of a sister who was the epitome of the heterosexual female. She was very attractive, thin, sporty and popular and involved herself in every social activity. At no time in this personal reflection am I suggesting that I had a bad relationship with my sister or my family. In fact we share a very special relationship, but the recounting of this is an important facet in the construction of my relationship with mathematics. I could not compete with her looks, body, sporting prowess and popularity and often the teachers who had taught my sister battled to believe that we were sisters.

Living in a small town narrowed the options of schools available. There were two primary schools and one high school and all three of them were coeducational institutions. Being an overweight girl attending a coeducational primary and high school came with its fair share of painful experiences. Because I did not fit into the ideal heterosexual female model, the incidents of bullying and teasing I endured at both primary and high school are

too numerous to recount and the damage done to my self-confidence illuminated the lie embedded in the saying “sticks and stones might break my bones, but words will never harm me”.

By the time I reached Standard 8³, my self-image and confidence levels were non-existent and the only way that I found that I could compete with my sister, and find a sense of belonging at school was to channel my energies into my academic progress, particularly Mathematics. In the community of my Mathematics classroom, I found a sense of belonging and I was able to create a new identity for myself albeit only for an hour a day. This identity was specific to the Mathematics classroom and was very different from the identities that I had in other subjects, during breaks, after school and at home. The identity I constructed in the Mathematics classroom was based on the socially constructed beliefs that success in Mathematics has the power to impress others, confers status and earns one the respected label of being ‘intelligent’. My achievement in Mathematics helped me regain some of the heterosexual power that I had lost by being an overweight and unpopular teenager in a coeducational high school. The view of power that I take here is a poststructural one that understands power as existing in the micro as well as the macro level and as something implicated in and through all our actions. Perhaps another explanation was that, due to the fact that I was considered to be more masculine than feminine by the boys at school, I felt that I needed to compete and challenge them in Mathematics, a subject socially constructed as a masculine domain.

Secondly, I had a strong desire to impress and gain my father’s approval with my Mathematical performance, a subject he believed being good at was proof of ‘real intelligence’. I quickly learnt that bringing home good Mathematics results impressed him. This desire to impress my father was directly related to the fact that he was a good sportsman and I felt that I had disappointed him by being overweight and choosing not to participate in sports, so unlike my sister. I felt that I could both compete with my sister and win my father’s approval by achieving in Mathematics.

³ I use the term ‘standard’ here as this was the correct terminology used prior to the introduction of C2005. Post C2005 saw the term ‘standard’ replaced by the term ‘grade’.

In my mind this was the way I could make him proud of me.

Mendick (2004) poses the following question, why do women perversely insist on making the wrong choices? That is exactly what I did. I chose at the start of Standard 9 to drop from higher grade Mathematics to standard grade Mathematics, thereby closing off a number of future career paths. I was more than able to succeed (I had achieved distinctions for Mathematics from the start of my Standard 9 year through to my final matric exam) at higher grade Mathematics, but I lacked the confidence to believe that I would succeed. I had worked the socio-cultural discourses about Mathematics into my identity project. Boaler (1997b) argues that in Mathematics classrooms, students learn more than just Mathematics – they learn what it is like to be a member of that community of practice, and whether or not they want to become participants. For reasons I have trouble understanding, I chose not to belong to the community of higher grade Mathematics and chose not to incorporate Mathematics positively into my identity project. The consequences of that decision have had far reaching effects on the career paths available to me, but far more importantly, have left me with a sense that I disappointed myself.

1.3.3. Charmaine – the gender student

In 2004 I registered at university, in search of the status of an academic degree that I had always desperately wanted. I was very embarrassed to admit that I was only in possession of a professional diploma, as I somehow viewed it as “a watered down image of the real thing”. It was only after I had enrolled at university to study for my Bachelor of Education Honours degree, specialising in gender and education that I began to realise the importance of gender in constructing social life, and that male-female relationships are characterised by inequalities of power. It was here also, that I was introduced to the power of feminist poststructuralist theorisations of gender and I began to realise that gender was far more fluid and complex than simply marking a block that indicated whether I was female or male.

1.3.4. Charmaine – the mathematics teacher

I never wanted to be teacher, and I only decided to pursue this as a vocation about three quarters of the way through my matric year. I have been the senior accounting teacher at Glenville College for the past 12 years. I never chose to become a Mathematics teacher, although when I studied for my Higher Diploma in Education and majored in Accounting and Business Economics, we were required to complete a minor course in Mathematics, which would equip us to teach up to Grade 10 level should the need arise. The need arose in January 2003, nine years after I had chosen to terminate my relationship with Mathematics when I was required to take over teaching a Grade 8 Mathematics class. I was torn between feelings of fear, panic, horror, dread and an excitement of taking up the subject that I had once really enjoyed.

What struck me about rejoining the world of Mathematics is the intense pressure that some parents place on their children to achieve in the subject. It is not uncommon to hear parents argue that their child will do Mathematics no matter what because they need Mathematics for their futures. That they will not entertain the thought of their child either opting to take standard grade Mathematics or opting out of the subject completely. The longest queues of parents, frantically clutching report books on parent-teacher evenings are those outside the Mathematics teachers' doors.

I returned to university to attain my honours degree, specialising in gender and education in the same year that I began teaching my first coeducational Mathematics class. And it was only when I was required to write an essay on gender and Mathematics that I began to realize that some forms of knowledge are more powerful and confer more status than others. I also realized that central to the curriculum are the disciplines that are concerned with reason and rationality such as Mathematics. After having read the literature around this for my assignments, I began to appreciate that the,

gender regime of mathematics classrooms that is the patterns of practices which constructs femininities and masculinities and orders them in terms of prestige and power, militates against the involvement and achievement of girls. As well as by gender, individual girls are also located by class, 'race' and sexuality and these locations interconnect and affect each other (Povey, 1998, p. 116)

I attempted to effect change in my own classroom by trying to be anti-competitive and encouraging a collaborative approach to learning. I used Outcomes-Based approaches like group work only to learn that, group work in Mathematics functions as a key site both for the gendered display of hegemonic forms of masculinity and for the subordination of others (Bhana, 2005). I attempted to connect the learning activities to the lives of the learners, and learnt that in some instances this too was found to be deeply gendered (Vithal, 2002) and also resulted in various levels of participation and resistance. However, I continued to strive for gender justice in my classrooms, but I am acutely conscious of the fact that due to external and internal pressures I probably fail more times than I succeed. I have failed most in the fact that I have expected all my students to engage with the abstract nature of Mathematics, to incorporate it positively into their identity projects, to enjoy it and to succeed at it. Most of all, given what I have learnt about Mathematics and gender I still find myself wanting all my learners to harness the power, prestige and status of Mathematics like I did when I was a pupil.

In attempting to develop an understanding of the relationship that I constructed with Mathematics, my school experiences, the need to compete with my sister and the desire to impress my father, I have come to see them as being inextricably connected to gender. The tensions that I experienced occupying certain identities both in and out of the Mathematics classroom are an important theme in my study. So too are the stories told to me, the stories we tell ourselves and each other about Mathematics, gender, our choices, who we are and how we make sense of the spaces we find ourselves in.

1.4. MATHEMATICS IN THE FURTHER EDUCATION AND TRAINING BAND

Public concern about the status of knowledge and skills of Mathematics learners in an increasingly technological society has drawn urgent attention to the Mathematical Literacy or numeracy competences of learners, with a particular focus on the demands that will be made on them when they leave school.

According to Vital & Volmink (Vithal, Adler, & Keitel, 2005, p. 15)

this has manifest itself as a preoccupation with mathematical literacy that can be seen in the Revised National Curriculum Statements (RNCS) and its related assessment standards for the general education and training curriculum. It also features in the new Further Education and Training (FET) curriculum for the senior secondary phase (grades 10 – 12).

The new curriculum which was introduced in 1997, Curriculum 2005 (Department of Education, 2004), was aimed at moving away from a “racist, apartheid, rote learning model of learning to a liberating nation-building and learner-centred outcomes-based one” (Department of Education, 1997, p. 5). Curriculum 2005 is based on the

values espoused by the Constitution of the Republic of South Africa (Act No 108 of 1996), and provides for the transformation and development of South Africa. Curriculum 2005 was reviewed in 2000, and among the recommendations of the Review Committee was the making of mathematics compulsory throughout high school (Chisholm, 2000 quoted in Mthiyane, 2007, p.23).

In fulfilment of this recommendation, the learning areas of Mathematics and Mathematical Literacy were introduced into the Further Education and Training Band (FET). This band covers Grades 10-12 at high school. From the beginning of 2006, it became compulsory for all learners in the FET band to make a curriculum choice between Core Mathematics and Mathematical Literacy. Amongst others, the reason for this change was an attempt at ensuring some degree of Mathematical literacy in all learners by the time they finished high school.

Vithal & Volmink (Vithal et al., 2005) argue that the insertion of Mathematical Literacy into the curriculum poses a serious challenge with regard to content and pedagogy, to avoid it being reduced to a watered-down version of the abstract Core Mathematics curriculum. According to the National Curriculum Statements, Core Mathematics enables creative and logical reasoning about problems in the physical and social world and in the context of Mathematics itself. It is a distinctly human activity practiced by all cultures. Mathematics is based on observing patterns with rigorous logical thinking and this leads to theories of abstract relations. Mathematical problem solving enables us to understand the world around us and make use of that understanding in our daily lives. Mathematical literacy provides learners with an awareness and understanding of the role that Mathematics

plays in the modern world. It is a subject driven by the life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyze everyday situations and to solve problems (Department of Education, 2004).

One of the key tensions that underlie the curriculum choice between Core Mathematics and Mathematical Literacy is the vast difference between the two learning areas in terms of the nature and purpose of each. In addition, according to government documentation, learners are permitted to move from Core Mathematics to Mathematical Literacy or visa versa only up until the end of their Grade 10 year. Thereafter, no further curriculum changes are permitted.

Vithal & Volmink (Vithal et al., 2005, p. 17) write that “the Mathematics-versus-Mathematical Literacy debate that has taken place in relation to the general education and training sector of Grade R to 9 in C2005 now arises more sharply in the new curriculum being proposed for further education and training in grades 10 to 12”. They continue that Mathematics education in Grades 10 to 12 is even more firmly positioned as a critical selector and filter for future roles in society. If one peruses the 2009 prospectuses for the various universities, it becomes evidently clear that learners have no choice except to take Core Mathematics if they wish to be considered for acceptance into most of the degrees offered. There are a very limited number of university degrees offered to students who have selected Mathematical Literacy as a curriculum option.

Having looked at the gendered nature of Mathematics, my own personal reflections and Mathematics in the new Further Education and Training, it now becomes important to locate the study. In the next section, I will provide details on Glenville College⁴, the school in which this study took place.

⁴In order to protect the identity of those involved in this research project, the name of the school, participants and teachers have all been changed and pseudonyms have been allocated to all.

1.5. THE CONTEXT OF THE STUDY

1.5.1. GLENVILLE COLLEGE: CONTEXT AND CHANGE – FROM SINGLE-SEX TO COEDUCATIONAL

Glenville College is seventy eight years old and has a strong grounding in the Catholic religion. Initially the school began as a boys-only school and continued in that tradition until the end of 1995, when the school took a decision to become coeducational. The decision to turn coeducational was influenced by two factors: ideological expansion and practicality. In 1995, four out of the six colleges that belong to this family of schools were already operating as a coeducational institution, and in following with the other schools the decision was taken to open Glenville College to girls as well as boys. A decision was also taken in 1995 to introduce a pre-primary section into the Foundation Phase. The reason for this was that there were very few pre-primary schools in the surrounding catchment area, and opening a pre-primary attached to the main school would ensure a steady flow of educationally better prepared learners from the pre-primary into Grade one. The decision to open a pre-primary section happened in tandem with a decision to turn the school into a coeducational institution. Glenville College opened its doors to pre-primary boys and girls for the first time in January 1996. The decision was made that the girls would be integrated into the school slowly and they would move up grade by grade through the school. This initial intake of girls is at present in Grade 11, hence my decision to work with them in this study. In 2008 the school will be fully coeducational with the last of the single-sex boys only classes matriculating at the end of 2007.

In 2003 I became Head of Department responsible for looking after the interest of the first girls who were moving up into the high school phase of the school. Over the years I have watched with interest how the girls have been integrated into the school and have been particularly concerned with their progress and participation. It has not been easy for this particular group of girls, considering that there were only 17 of them and approximately 286 boys. They had to learn to be assertive, stand up for their rights and resist opposition to their presence from some teachers, some parents and some of the boys themselves.

After taking an interest in the area of gender and Mathematics, I began to pay particular attention to the academic achievements of this group of girls. Consistently from Grade 8 to Grade 10, girls from within this group have occupied four out of the top five academic places in the grade, achieving ‘A’ aggregates every year. When I began to focus specifically on the Mathematics results of these girls, I noticed that although they were academically stronger than the boys, the pattern changed slightly in Mathematics. Although doing well, their Mathematics result in most cases was their lowest mark (see Appendix 1). Although the focus of this research is not on the Mathematical achievement of the girls, it was the logical starting point to finding out how these Grade 11 girls related to Mathematics and what Mathematical stories they had to tell.

1.5.2. THE RESEARCH SITE

Glenville College is a co-educational independent Catholic school that occupies prime Berea property and commands a magnificent view of Durban. The ethos of the school is based on the commandment “Love the Lord your God ...Love your neighbour as yourself”. A true Christian life is based not only on belief and religion, but also on putting our faith into practice. For Glenville College educators, there is a challenge to lead by example and to lead our children to a place where they have begun the journey of acquiring a set of life-giving values: respect for the dignity of each person, honesty, justice, solidarity and peace. By doing so, we are helping children achieve their full potential in life.

Glenville College is in effect three schools in one, with the Foundation Phase running from Grade 00 to Grade 3, the Intermediate Phase from Grade 4 to 7 and the Secondary School from Grade 8 to 12. Although still one school, the Foundation Phase and Intermediate Phase fall under the authority of the Principal of the Primary School, a position created in 2007. This forms part of a long-term plan to enhance the management structure of the school, and a new High School Principal will be instated at the beginning of 2008. The need for this management restructuring came as a result of an increased enrolment into all the phases of the school, and at present the number of learners enrolled at Glenville College is 789, made up of 237 enrolled in the Foundation Phase, 252 in the Intermediate Phase and 300 in the High School.

Learners write the Independent Examinations Board (IEB) examinations, and Glenville College has achieved a 100% pass rate in the matriculation examinations for the past 35 years. In 2006, 93% of the matriculants achieved a pass with a university entrance compared to 78% for all IEB schools and a national average, excluding IEB schools, of 18%. Twenty-five percent of the matric learners who wrote the final examinations achieved 'A' aggregates and 75% achieved passes with merit. The statistics over the past 35 years show that Glenville College is a strong academic school.

I chose this site in order to do an in-depth exploration of how Grade 11 girls construct their relationship to mathematics in this specific learning environment. I refer the reader to Chapter 3 where detailed reasons are provided for the selection of this site.

1.5.3. THE MANAGEMENT AND TEACHING STAFF

The management structure in the high school is made up of the College Principal, Deputy Principal and 5 Heads of Department (HOD's). The college principal, deputy principal and 3 HOD's are male and the remaining 2 HOD's are female. The teaching staff in the high school consists of 24 teachers, comprising 14 male teachers and 10 female teachers. There are 21 white teachers, 1 Black teacher and 2 Indian teachers. I will provide greater details regarding the Mathematics department in Chapter 3.

Glenville College is a well-run, well-resourced, friendly, middle-class independent school and very different from the over-crowded, under-staffed, under-resourced, violent government schools in the greater Durban area. The school is one of a small number of independent elite schools in South Africa. In this environment privilege has been converted into a constructive learning environment with the goal of producing learners who are equipped with the necessary tools to enable them to achieve their full potential in life.

1.5.4. THE LEARNERS

Learners at the school come from a range of socio-economic groups, with the majority coming from middle to upper-middle class backgrounds. Some of the learners come from very affluent and elite backgrounds but because of the Catholic ethos and the

fact that the school does not like to turn learners away, particularly if they are Catholic, there are some learners who come to the school on reduced fee bursaries. They are in the minority though, and often battle to identify with the learners who have a wealth of material resources available to them.

As this research focuses on participants in the high school phase, I have chosen to provide details of this phase only. There are three classes per grade with an average of 23 learners per class. The school's policy is not to exceed 25 learners per class. The majority of the learners are White with a fairly large population of Indian learners and a smaller number of Black and Coloured learners. Catholic education has never discriminated against children on the basis of their race and has a long history of accepting children of colour into their schools even when under the apartheid regime it was illegal to do so. The ratio of girls to boys in the high school is approximately one girl to every four boys. The school has an aggressive marketing campaign to increase the number of girls enrolled into the school. There are a total of 79 girls in the high school and 17 in Grade 11. It was from these 17 that the participants were selected. The racial composition of the 17 Grade 11 girls is: 10 white girls, 5 Indian girls and 2 black girls.

Although Glenville College is a Catholic school, many of the learners accepted into the school are not practicing Catholics. Besides Catholics, the student body is made up of learners who are practicing Hindus, Moslems, Anglicans, Charismatics, Methodists and some who declare they are either atheists or agnostics. If learners are not catholic, they are still required to attend masses held at school and to participate in the religious education programme of the school.

After dealing with the learners at Glenville College in general, it becomes pertinent to narrow the focus down to the six girls who were pivotal to this study. The following table provides the biographical details of the girls who participated in the study.

Table 1.2. THE GIRLS – BIOGRAPHICAL DETAILS

	NAME	DETAILS
1	Nadiya	Nadiya is a 17 year old Indian girl. She is an only child in her family. Nadiya has a left hip impediment, through Perthes disease at birth, and this causes her to walk with a fairly severe limp. Her family is Anglican. Although her father did not attend university, he studied further through correspondence and is currently employed as a communications manager at an airport. Her mother has a degree in psychology and initially worked as a social worker. She is currently employed as a human resources manager at an insurance company. Both Nadiya’s parents emphasize the importance of education and sacrifice much to keep Nadiya in a private school. Nadiya says that she works very hard because she knows how much her parents have sacrificed to keep her here at Glenville College. Nadiya arrived at Glenville College in 2004, the start of her Grade 8 year. This was also the first year that the girls moved into the high school phase at the school. Since Grade 8 Nadiya has been placed in the top five students in the entire grade. She wishes to pursue a career in the field of Marine Biology when she finishes school next year.
2	Rehana	Rehana is a 16 year old Indian girl. She is the oldest child in the family and has three younger sisters. All four sisters attend Glenville College. The family is Tamil and is active in practicing their faith. The family travel extensively and Rehana was the first girl to represent the school on an international exchange with its sister school in England. Rehana’s dad is a qualified pharmacist, but is currently a director of a manufacturing business. Her mom is an Intermediate Phase educator. Both Rehana’s parents emphasize the importance of education although her dad pushes her harder than her mom. Rehana was part of the first group of girls that was admitted into Glenville College in Grade 0 in 1996. Since Grade 8 Rehana has been placed in the top five academic students in the entire grade She wishes to pursue a career in the field of financial engineering when she finishes school next year. She was introduced to this field of commerce whilst visiting Singapore with her family.
3	Juliet	Juliet is a 16 year old White girl. She is an only child in her family and thinks that personal space is vitally important. She cites the reasons for her needing her personal space as being because “her parents are both loners, not antisocial just you know they are into opera and things like that”. Juliet is not your typical 16 year old girl; she is not particularly interested in fashion, make-up or boys and has no interest in ‘following the crowd’. She does not mind spending the odd occasion with the girls talking about “girlie things” as she puts it, but stresses this is very occasionally and only in very limited doses. She is an avid reader. Her father has a high IQ and Juliet thinks that she too has a high IQ although she has not been tested. Juliet’s family is Christian although no specific denomination was given. Her dad is the marketing director at an appliance company. Her mom studied to be a nurse, but currently owns her own hospital planning business. The family travels extensively and attempts to expose Juliet to as many opportunities and experiences as possible. Both her parents emphasize the value of education and have told Juliet that they have enough money for her to pursue any academic field and study anywhere she wants to. Juliet came to Glenville College in 1997 and she has successfully come first in the grade from the time she arrived until today. She was awarded an academic scholarship in 2003 and this scholarship will run for the duration of her high school education. She has no idea what career she wishes to pursue when she finishes school next year and is not stressed about this. Juliet has always wanted to be a writer and would love to pursue a career in English.

4	Chrystal	<p>Chrystal is a 17 year old White girl. She is the youngest child in her family and has a stepbrother and a stepsister who are 15/16 years older than her. Although Chrystal is slightly overweight this has not stopped her from involving herself in all the sporting activities offered by the school. She says that although she is often embarrassed especially during swimming, she still loves to participate. She comes from a Christian family and made reference to belonging to a charismatic church. Chrystal is a fairly reserved. Her dad is a financial advisor for an insurance company and her mom owns her own hairdressing salon, her mom is not a hairdresser though. Both her parents emphasize the value of education and Chrystal wishes to pursue a career in graphic design. She does not wish to attend an Institute of Technology but wishes to go to a university as she feels that the graphic design course there will be 'more in-depth'. Chrystal arrived at Glenville College in 2004, the start of her Grade 8 year. This was also the first year that the girls moved into the high school phase of the school.</p>
5	Abigail	<p>Abigail is a 17 year old White girl. She is the oldest child in her family and has a five year old stepbrother. Her parents are divorced and her mother remarried. Abigail lives with her mother and stepfather. The family is Methodist. Abigail's real father is a mechanical engineer and her stepfather is an electrical engineer. Her mom did not attend a university when she finished school as she married very young and her first husband did not allow her to study so she was a secretary. Only after the divorce did Abigail's mother study through Unisa to obtain her degree. At present she is the human resources manager for a shipping company. As she did not know much about the shipping business she chose to study further in order to help her in her new career and only completed her studies this year. Abigail's mother, stepfather and real father value an education and push Abigail fairly hard to succeed at school. Her stepfather is already in the process of researching tertiary study options for Abigail. She wishes to study at Rhodes University when she finishes school and wants to do a four year fine arts degree, with the possibility of lecturing in fine art at a later stage. Abigail came to Glenville College at the beginning of 2006, which was the start of her Grade 10 year. She attended an all girls' school in Durban North for Grades 8 and 9.</p>
6	Madison	<p>Madison is a 16 year old white girl. Her parents are divorced and she was the only child until her father and his new wife had a baby girl two years ago. Her father lives in Germany and Madison has contact with him fairly often. She visited him during her July holidays this year. The family is practicing Roman Catholic. Madison lives with her mother and aunt. Her mom was medically boarded a number of years ago and her father is an IT specialist. Her father insisted that she attend a private, co-educational school although her mom would have been happy to send her to the "local government school down the road". Madison does not think that her dad is particularly interested in her academic progress and says her mom, although very supportive does not really put pressure on her. Madison came to Glenville College in 1997. She would desperately love to be a Professor of History, but realises that being her mother's only child she will have the responsibility of taking care of her mother when she finishes school and studying. So she is looking into pursuing a career in the legal profession as this will give her enough money to take care of both herself and her mother.</p>

1.6. RESEARCH QUESTIONS

The girls in this study have largely had the overt barriers to education removed by attending a prestigious independent coeducational school where privilege has been converted into a very constructive learning environment. Based on my personal experiences of Mathematics as a school pupil, a gender student and a Mathematics teacher, my hypothesis is that unless these girls are able to incorporate Mathematics positively into their identity work, then compulsory Mathematics or Mathematical Literacy in the FET band will remain largely unsuccessful at getting girls to enjoy it and develop a positive conception of it.

The study attempts to answer the following question:

How do Grade 11 girls in a Catholic co-educational independent school construct their relationship to the learning areas of Mathematics and Mathematical Literacy?

In answering this question, the following two sub-questions will be answered:

This relationship is constructed by:

1. How do they see themselves in relation to Core Mathematics or Mathematical Literacy?
2. What are their gendered experiences of Core Mathematics or Mathematical Literacy?

The question of how the girls “see themselves” is an identity questions and draws attention to the various ways each girl positions herself relative to Mathematics and Mathematical Literacy, the second draws attention to their experiences both inside and outside of the classroom environment. In this thesis, identity and experiences are focal points as they are important in mutually co-constructing the girls’ relationship to Mathematics and Mathematical Literacy.

This is a qualitative study that employs interviews, observations, participants’ journals, document analysis and field-notes as methods of data collection.

1.7. CONCLUSION

In this chapter I have described my motivation for exploring how these six girls construct their relationships with mathematics by exposing my own relationship with Mathematics and the various ways that I worked the socio-cultural discourses that surround Mathematics into my identity project. I focussed on the gendered nature of Mathematics and how this makes it problematic for girls to engage positively with it and to enjoy it. Next, I touched on the literature surrounding the FET which highlights that Mathematics education in Grades 10 to 12 is even more firmly positioned as a critical selector and filter for future roles in society. I presented a detailed description of the research site and concluded by providing my research questions. I now move to the Literature Review Chapter.

CHAPTER 2 LITERATURE REVIEW

2.1. INTRODUCTION

This research explores the ways in which 2 Indian and 4 White Grade 11 girls from an independent, predominantly middle to upper middle-class Catholic school construct their relationship to Mathematics. This study illustrates how doing Mathematics is doing gender and how the association with Mathematics underpins identity work as the category “girl” is lived out amongst sixteen and seventeen year olds. Further to this, this study also shows how sexuality is embedded within the doing of gender and doing Mathematics is not only doing gender but sexuality as well. When each of the girls in this study relate to Mathematics they do not relate to the learning area of Mathematics or Mathematical Literacy alone, but their relationship to Mathematics is embedded within social processes including sexuality, gender, race, class and age and these are actively acted upon, as this study will show.

Throughout this thesis, I argue that the discourses that are most central to Mathematics construct it as ‘hard’, ‘absolute’, ‘a proof of intelligence’, ‘certain’, ‘objective’ and that these discourses inscribe Mathematics as masculine and this makes it difficult for girls to form a positive association with it. What this thesis will show is that the girls in this study associate with two kinds of Mathematics: that of Core Mathematics and Mathematical Literacy and it is further argued that they relate to Mathematics in terms of the hierarchies and power vested in each. The girls in this study do not simply reproduce the idea that Mathematics is masculine, but they work on this. The Core Mathematics girls use it to their advantage and craft out power for themselves. Similarly, the Mathematical Literacy girls, although they reject Core Mathematics enjoy Mathematical Literacy. However, because of Mathematical Literacy’s construction by learners and teachers as easy Mathematics, these girls see themselves as subordinate to Core Mathematics girls.

In a South African context, the Gender Equity Task Team (GETT) (Wolpe, Quinlan, & Martinez, 1997) report focused on how girls do not tend to pursue Mathematics, pure or applied Sciences at school. The report documents that the reasons for this are

complex and multi-faceted. They include that the image of Mathematics and Science have been constructed as male domains and how apartheid education combined with deep cultural constructions of gender contributed to fewer girls, particularly African girls, taking up Mathematics. The focus on African girls and the need for access to and development of Mathematics in schools is a justifiable and important area of development as Mthiyane's (2007) research on African girls and Mathematics and Science suggests. She argues that there is a need for research that will contribute towards building an understanding of what schools can or may do to create learning environments where girl learners are interested in Mathematics and Science and succeed in these subjects. Coupled with this, the GETT (Wolpe et al., 1997) report highlights the need for finely focused studies enabling the incorporation of qualitative differences in the experiences of girls of different cultural backgrounds in different locations and school types. This thesis contributes to the literature on girls and Mathematics in South Africa by focussing on girls in a private elite context where there is an obvious expectation that the increased resources available to girls automatically implies a better and more positive relationship with Mathematics. What this thesis shows is that the relationship between Mathematics and girls is far more complex than one that can be solved simply by the improvement of resources. This study of upper income girls focusses on the construction of gender identities and highlights that the access to better resources is just one small part of the complexity of the relationship that girls develop with Mathematics.

South Africa is in a process of transforming its educational system in the hope that it will produce the kinds of citizens who can meet the challenges of the 21st Century. These challenges, according to Mthiyane (2007), include the knowledge explosion, information technology, and competitiveness in the global markets amongst other factors. In order to adequately prepare all learners to successfully meet these challenges, the country has prioritized the acquisition of Mathematics skills to such an extent that with the introduction of the new Further Education and Training (FET) band in 2006, Mathematics and Mathematical Literacy have become compulsory learning areas for all learners from Grade 10 through to Grade 12. However, because the girls in this study are forced to do

Mathematics, the reality of the situation is that although they all see Mathematics as useful for entrance into tertiary education, it does not mean that they will incorporate it positively into their identities or construct a positive relationship with it. All six girls in this study expressed that a degree of success at Mathematics and not enjoyment of mathematics was essential because success would allow them access to further education and careers.

The literature focusing on identities is accompanied, as it is in this thesis, by attention on how social factors such as gender, mathematics, class, race, age and sexuality influence the construction of relationships. Mathematics is embedded within a social institution, is highly masculine (Paechter, 2001a) and because of the power and prestige vested in it, permits only particular associations with it. Using a focus on identities is important in telling us how the relationship and association with Mathematics is being shaped and how power dynamics are embedded within it as girls construct meaning for it. I begin this literature review by briefly discussing the gendered nature of Mathematics and how women have historically been constructed as being outside the arena of rationality and reason. I continue by discounting biological and sociological accounts of gender in favour of adopting a feminist poststructural view, in which I explore its central tenets of identity, discourse and power. I then introduce a brief discussion on the relatively unexplored area of how the association with mathematics underpins sexual identity work. At the end of this chapter, the thesis looks at the South African context from which these girls emerge and in doing so, draws on some of the literature from South African authors that have informed areas of this research.

2.2. GENDER AND THE NATURE OF MATHEMATICS

In the school curriculum some forms of knowledge are quite clearly labelled by gender, and, of these, those signified as masculine are usually more powerful and confer more status. These subjects are usually those associated with reason and rationality. Girls have traditionally been excluded from such forms of knowledge, initially “simply through curriculum exclusion, and, more recently, by their being marked in ways that adolescent girls in particular find difficult to reconcile with their sense of self” (Paechter, 2001a, p. 7).

Since the Enlightenment period of the eighteenth century, reason and rationality have been seen as forming the basis of Western philosophical thought. This dominance of decontextualised reason as a basis for judgment has now become so embedded in the way we think that we more or less take it for granted. To say that someone is irrational is not a value-free comment but suggests that their opinions are less worthy of consideration than those of other people. The origins of the dominance of reason over emotion are gendered. Enlightenment thinkers saw reason as the province of males and emotion as female territory.

Although we now recognize that girls are as capable of rational thought as boys, it remains the case that girls are more likely to use alternative methods of making decisions. Paechter (2001a) writes that girls are more likely to argue that strictly reasoned conclusions are not always an appropriate way to approach certain situations. In this belief, they could be described as using emotion, rather than logical intelligence. Paechter states “that males are more likely to use a rationalistic, justice perspective that emphasizes moral principles, females to take a non-rationalistic, ‘caring’ approach that focusses on the support and preservation of human relationships” (2001a, p. 5) . Therefore the association of masculinity with reason, and femininity with alternative approaches, is both traditional and stereotypical and at the same time has a basis in actual behaviour and this affects how girls and boys relate to Mathematics as a subject and how they contest, adjust and accept these dominant positions. This perceived difference between males and females in the ways in which they approach moral decision-making may also have effects in terms of their feeling comfortable in relation to Mathematical thinking. “If males generally give precedence to reason as a way of making decisions, they are more likely to be comfortable with Mathematical procedures and the elicitation of one single right answer” (Paechter, 2001a, p. 5).

Boys are likely to be relatively comfortable with mathematics because it resembles the way in which they approach important questions in their lives. Girls, on the other hand,

are more likely to find that the single correct answer required by Mathematics is something unique to that subject. In other subjects, success can be achieved by finding a variety of solutions. Therefore, in order to succeed in the Mathematics classroom, as opposed to many other curriculum areas, they will have to change their dominant mode of thinking, and they may find this shift difficult to reconcile with their sense of self.

Not only is reason stereotypically associated with masculinity, Mathematics is also perceived as the ultimate rational subject. Walkerdine (1998) argues that success at mathematics is taken to be an indication of success at reasoning. Mathematics is seen as a development of the reasoned and logical mind. When girls consider Mathematics as a potential career path, they are in fact considering whether they are going to study a subject that is associated with the masculine gender, both in terms of its image and its incongruence with their preferred thinking styles.

The association of Mathematics with reason and hence masculinity, make many adolescent girls reluctant to take the subject. Success and enjoyment of Mathematics is in direct conflict with stereotypical images of femininity. Head (1997) takes the view that girls who are seen to enjoy Mathematics, are visibly not conforming to feminine models and this may not only result in teasing, but also in a questioning or undermining of some aspects of their identity by peers, teachers and even themselves.

Having discussed how gender and the nature of Mathematics are interwoven, I now turn the focus of this chapter to discussing how girls are active agents in the construction of their identities. I do this by arguing against and discounting biological accounts of gender in favour of adopting a poststructural approach which allows me to explore the complex ways that each girl comes to understand herself as she actively constructs a fluid relationship with Mathematics.

2.3. BIOLOGICAL AND SOCIOLOGICAL ACCOUNTS

Biology has a long history of being used to exclude women from education. I discount biological explanations on the basis that both Hanna (1996) and Mendick (2004) show that research on gender similarities and differences has found that in fact there is no physical or intellectual barrier to the participation of women in Mathematics. Many of the results of research have firmly located the problem within the girls themselves and not within the social structures. As a result researchers have taken initiatives to improve girls' attitudes, confidence, self-esteem and anxiety levels. However, this rejection of the social in favour of the individual tends to invoke biological explanations which have been discounted.

While the various research projects have been helpful in highlighting some of the potential causes of girls' under-representation in Mathematics, many have been criticised for ignoring the contexts within which girls learn, and for essentialising girls. I find these perspectives problematic because they maintain that there is a deficiency in girls, and that girls need to be provided with the missing Mathematical skills or experiences. In concluding this section I draw on Walkerdine's (1998) argument that gender differences have much to do with a myth regarding male superiority in Mathematics. However, the problem arises because this myth is so embedded within, and colours the view of society, that it has come to be perceived as true.

In choosing a poststructural lens over a biological or sociological framing, I argue that this positioning is more appropriate as an alternate lens for exploring the various ways that girls construct their identities in relation to Mathematics. This is highlighted in greater detail in the next section on poststructuralism.

2.4. POSTSTRUCTURALISM

Poststructural theorizing is useful for a study of girls and Mathematics because it allows an exploration into the complex ways that each girl comes to understand herself as she actively constructs a fluid relationship with the formal curriculum and the social

practice of Mathematics in the specific context of an independent middle to upper-middle class school in Durban.

Poststructuralist approaches are very different from those based on sex-role socialisation:

Poststructuralist theory argues that people are not socialised into the social world, but that they go through a process of *subjectification*. In socialisation theory, the focus is on the process of shaping the individual that is undertaken by others. In post structuralist theory, the focus is 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, 1994, p. 13)

Lee (1992) writes that a poststructural feminist analysis can expose the historical and contemporary oppressions of women of all races both in organisations and societies through daily interactions that lead to the creation of multiple identities based on gender, social class, sexuality and race. Poststructural feminism focusses on how people actively negotiate, construct and contest gendered identities in everyday actions. It assumes that individuals are active agents, not only as people who attach meaning to their actions, but also in a very fundamental sense as people who construct their very identities as boy/girl.

If one takes a poststructuralist view of gender, we can see that “masculinity and femininity are discourses which are imbued with power/knowledge relations and act upon individuals within particular societies” (Paechter, 2001b, p. 48). What this means is that how individual males and females behave involves an enactment of their gender roles, as interpreted by them in their social context and as constrained by the experiences of their bodies. We are all constantly and actively engaged in the social work of doing gender but our choices within this are “severely constrained by oppositional ways of thinking” (Mendick, 2006, p. 24). Drawing on poststructural theory helps me to interrogate gender, particularly the gender identity and gender role behaviour of each of the six girls in this study as they go about constructing their relationship to the learning area of Mathematics. Using a poststructural lens equips me to consider how “discourses of Mathematics, masculinity and femininity are constructed and maintained, and how they are supported by

power/knowledge relations” (Paechter, 2001b, p. 48). It is within and around these discourses that the girls in this study actively engage in producing and reproducing their identities and relationships.

Poststructuralism is valuable for this educational research on girls and Mathematics for a number of reasons. They include the fact that the girls in this study are not autonomous, unified wholes, separate or distinct from those discourses which regulate mathematics, femininity, sexuality and all other social activity. The girls in this study are identified and identify themselves according to the positions that they occupy within these discourses. At this point however, it is important to consider that the girls in this study have social and economic capital and therefore it is not simply about discourses, but also about how these girls use these discourses which are contextually specific around issues of race, class and gender.

The inter-relatedness of race, class and gender becomes vitally important when researching gender and mathematics in a South African context. Researchers working in the South African context make it explicitly clear that race and class play a specific role in the relationship between gender identity and mathematics (Bhana, 2005; Wolpe et al., 1997). Bhana (2002, p. 22) writes that “how people work on their identities and how identities are worked upon is a key concern of cultural studies. The question in cultural studies is: how are processes produced and circulated within material, social and cultural conditions which impact on the production of identity?”. Issues of race, class, gender and sexuality that constitute cultural dynamics are significant. It is important to recognize the social locations and material realities as they impact on identity and create the conditions for power relations (Epstein & Johnson, 1998). Within specific circumstances, race and class impact on identity in different ways. Identity is produced in everyday schooling contexts which help shape and reshape these wider structures of inequalities.

Poststructuralism takes social complexity seriously and attempts to work with it rather than reduce and marginalize it. This provides me with the opportunity to explore the

“daily struggle and muddle” (Lee, 1992, p. 7) that these girls experience whilst developing an association with mathematics. Finally, poststructuralism theorises the power and provides a productive way for me to account for the ways in which power operates on both the micro as well as the macro-level and, as something that is implicated in and through all the actions of these girls. As a social practice, education is vitally concerned with understanding the production of meaning and the negotiation of social relations and relations of power. It provides a better way than other theories of understanding what it means to be a girl engaged in the project of Mathematics in a contemporary Catholic independent and coeducational school.

According to Davies (1994), within poststructural thought, all pedagogic work is identity work. School Mathematics operates as a discourse and its discursive practices position girls as either able or not able to act in powerful ways. The social context of the classroom is not separated from the individual as was thought to be the case in theories of socialisation, but is in or constitutive of the learner. “To the extent that discursive practices shape or make real certain ways of being, they are constitutive of the persons who take them up as their ways of speaking the world and themselves into existence” (1994, p. 44). Conceptually, the notion of individual ability is replaced with a focus on the ways in which girls are produced within the discursive practices of Mathematics, recognising that there are many other family and public discourses that also influence identity formation.

Davies (1994) continues that as girls engage in the discursive events of the classroom, and they attempt to learn Mathematics, they come to know themselves as legitimate participants or not in the social practice of Mathematics education. “This coming to know is not a cognitive, conscious event, but rather an unconscious sense of whether or not their voice and presence in the discourses are valued” (p.42). Walkerdine (1990) reminds us that an individual can become powerful or powerless depending on the terms in which her subjectivity is constituted.

The aim in this section has been to introduce some of the key aspects of poststructuralism that have provided a valuable theoretical tool in understanding the girls in

this study on Mathematics and gender. These key aspects formed the basis of my analyses in the remaining chapters. In taking a poststructural view, in which discourse is a central tenet, it becomes important to take into account that it is within a range of discourses of Mathematics, femininities, sexuality, masculinities and schooling that each of the six girls' educational experiences come into being. Therefore, I view the problem of gender and Mathematics as not being located in the girls themselves, but rather in the discursive context of gender, Mathematics, sexuality and schooling around which they construct their identities.

2.4.1. Power, subjectivities and identity

The girls in this study are positioned within a range of discourses of Mathematics, femininity, schooling and sexuality and it is within these discourses that their experiences are constituted. These experiences are important in shaping identities that are relational and shot through with power. These discourses position them within networks of power, and discipline them into certain ways of being and acting and create within them a certain relationship to self. This power inhabits each girl, shaping her from the inside as well as the outside. Power is inscribed in our ways of being and in the spaces we inhabit. Power is not something that is acquired, seized or shared. Nor is it something that one holds on to or allows to slip away; power is exercised from innumerable points (Foucault, 1976). Foucault (1980) maintains that power is productive and not merely coercive, that is, it constructs subjectivities or identities. Power is exercised locally and that is also where it is resisted. Mendick (2004) argues that the Foucauldian idea that wherever there is power there is also resistance, is important because it captures the double-edgedness of power. For the girls in this study, this means that they are positioned within networks of power that exist within the school, families, the mathematics classes and other social groups that disciplines them into certain ways of being and acting. However, they have agency and actively choose which positions they take up and which they resist.

Using a poststructural framework, I acknowledge that identity is actively constructed as people interact. They do not do so in linear ways but engage with social

circumstances to produce and reproduce identities. In this study, it is productive for me to read the construction of each girl's identity as a verb rather than a noun. It is something that they do, and are done by, not something that they are. It is the product not the source of their actions. In this thesis, I see the identities of the girls as fluid, contradictory, transforming, and relational. Who they are is always in a process of formation and is never complete. And throughout this process, our notions of who we are always narrated,

Identity is always within representation. Identity is not something which is formed outside and then we tell stories about it. It is that which is narrated in one's own self (Walshaw, 2001, p. 7).

Identity is not fixed, absolute or pre-given, but according to Hall (1990), is a product of historically specific practices of social regulation which is in continual construction and reconstruction. The identities of the girls in this study shift and fragment across "discourses, practices and positions" (Hall, 1990, p. 4) and are constantly in the process of change and transformation, always in process and never entirely complete. Castells (1997) argues that the girls in this study are located in myriad power relations at the micro level of society, and in a complex web of discourses that offers them many ways of seeing and being. They have the agency to draw on these consciously and unconsciously, and in differing ways take up or reject the positions offered to them. Each one of the six girls in this study distinguishes herself from others, and in relation with others. In this thesis, I argue that the identity construction of each girl is a "dynamic process grounded in history, and desire, subjected to description and reflection and constantly presented to and negotiated with other people" (Hall, 1990, p. 4). Walker (2001) writes that because of inner diversity and a self that is fractured, contradictory and shifting, the narratives presented by [the girls in this study to me] often were and will be fraught with contradictions. Walshaw (2001, p. 482) proposes that "colliding, contradictory discourses produce fractured and fragmented subjectivities for [these six girls in this study], and subjectivities that traffic in conflict tell tangled stories of female subjectivity in the mathematics classroom". Each one of the girls had an individual story to share, often fraught with contradictions and uncertainty, of the ways in which they negotiated, accepted

and rejected the various positions available to them whilst actively engaging with mathematics.

2.5. The relationship between mathematics and sexuality

A central theme of the literature reviewed in this chapter has been that mathematics is about doing gender (Bhana, 2005; Mendick, 2004, 2005a, 2005b, 2005c, 2006). However, doing gender is also about doing sexuality. Drawing from Ernest (2004b) it is clear that gender, mathematics, sexuality, race, religion, age and class are all connected in an intricately woven web, that allows each girl the possibility of developing multiple sexual selves in different social contexts that change over time. Using Vithal's (2004) research on street children and the development of identities, it is important to realise that for the period that these six girls are in the mathematics or mathematical literacy classroom, they are participating in a particular world that coincides or collides with their different sexual identities.

Mandel and Shakeshaft (2000, p. 75) argue that,

during the secondary school years, adolescents are expected to forge an identity, often in the face of overwhelming peer pressure and scripts by which to conform. They must deal with sexual feelings that may not only be overpowering, but also have taboos (especially against female sexuality) and proscriptions attached to them. These years are critical because, neither child nor adult, adolescents must tackle two major tasks, usually on their own: identity formation and the development of self-worth.

They continue that adolescence is not only time when friendship, social acceptance by peers, and a sense of belonging grow in importance, but it is a time when physical, sexual, cognitive and emotional changes significantly alter the way young adults think about themselves and each other. Thorne (1994) argues that the transition from the relatively asexual gender system of childhood to the overtly sexualized gender system of adolescence not only involves dramatic bodily changes, but also entails complex shifts in adolescent gender relations and systems of meaning. Mandel and Shakeshaft (2000) continue that in school, the formation of identity occurs in a gender system organized around the institution

of heterosexuality whereby fairly rigid adherence to gender roles becomes the norm, and peer cultures take on an active role in enforcing these roles.

Research in recent years has increased awareness of the construction of gender and this has resulted in a greater understanding of how subjects become gendered beings, that is how and why children take up particular ways of being boys or girls. Renold (2003, p. 178) writes that researchers have extended their “understanding of heterosexual practices, from sexual activity, to a wide range of discourses and performances, through which boys and girls define, negotiate and essentially construct their gendered selves”. In understanding the relationship between sexuality and gender, I wish to draw on Butler’s (1994) notion of performativity to understand the construction of gender and to look at the ways that girls assert their gendered subjectivities.

Butler (1994) uses the concept of a heterosexual matrix to identify the naturalized process of gender heteronormalisation. She perceives this heterosexual matrix as,

a grid of cultural intelligibility through which bodies, genders, and desires are naturalised. It is a hegemonic discursive/epistemic model of gender intelligibility that assumes that for bodies to cohere and make sense there must be a stable sex expressed through a stable gender, masculine expresses male, feminine expresses female, that is oppositionally and hierarchically defined through the compulsory practice of heterosexuality (Butler, 1994, p. 151).

How gender and heterosexuality intimately and powerfully intersect is critical to an understanding of the construction of individuals as gendered and sexualised subjects.

Butler (1994) argues that how and where masculinities and femininities are played out, culturally and historically is how hegemonic forms of masculinity and femininity become established, circulated and confirmed. It is the repetition of the performance of masculinities and femininities that constructs and reconstructs the masculine and feminine subject. She continues that gendered identities are constructed from the performances of subjects and the performances of others towards them. Paechter (2003b, p. 544) argues that children repetitively perform their femininity and masculinity in order to ‘do it right’ in

front of their peers and others and it is through this repetitive process that the feminine and masculine subjects become defined and constructed. At this point it becomes crucial to point out that the concept of gender 'performance' is always one enacted within strictly defined boundaries; "what counts as a performance of masculinity or femininity is rigidly defined and policed by the socio-cultural context of the particular time" (Paechter, 2003b, p. 544). Paechter continues that getting one's gender performance right is critical, as individuals run the risk of being ostracised if they do not conform to what are generally upheld as appropriate behaviours.

Similar to the construction of gender,

sexuality is socially and culturally constituted, with desire constructed and policed through powerful societal discourses and social practices that are institutionally and individually supported at both the macro and micro levels in society (Paechter, 2003c, p. 73).

Sexuality, like gender, is perceived as shifting, changing, flexible and fluid. It is produced by society in complex ways through diverse social practices, individual and social definitions. It is about relations of power. Epstein & Johnson (1998) argue that sexuality and sexual difference are not only socially produced, they are also invested with power. Weeks (2003, p. 19) points out, "sexuality is not a given, it is a product of negotiation, structure and human agency". Sexuality is more broadly about relationships, life choices and practices, dispositions and pleasures, desires and fantasies, all of which are aspects of everyday life in which both children and adults engage.

Epstein & Johnson (2000, p. 189) contend that,

sexuality, especially heterosexuality, is not only present but crucial to the organization of primary schools, both explicitly and implicitly and thus in ways similar to secondary and further education sectors, a key social and cultural site for the production of children's sexual relations and identities.

Of particular importance to this study is the way that factors that constitute the knowledge of what it means to be a girl are based on multiple discourses of femininity that are culturally and historically available. These discourses intersect with sites of identity

such as race, religion, class, mathematics and sexuality. “Sexuality may be thought about, experienced, and acted on differently according to age, class, race physical ability, sexual orientation and preference, religion, and region” (Vance, 1984, p. 17).

This study focuses in part on girls from middle to upper-middle income contexts in the construction, management and negotiation of their sexual self whilst engaging in the social practice of mathematics. Bhana (in press) writes that, “it is important to recognize the social locations and the material realities from which the [girls] in this study emerge as they impact on identity and create conditions for power relations”. She continues that “coming from a history of privilege and the accumulation of social and economic capital, the [girls] in this study construct their gendered identities in a context of material and social privilege as they talk about future tertiary study and successful careers.

2.6. CONSTRUCTING MATHEMATICAL IDENTITIES

The mathematical identities that the six girls in this study construct are shaped by their past and current experiences of mathematics. Ernest (2004b) writes that because learners bring their entire selves into the Mathematics classroom, their Mathematical identities are based in part on their personal experiences. He writes that learners construct Mathematical identities that influence their learning of the subject. A Mathematical identity is only one of the many possible identities that the girls in this study can construct. Ernest (2004b) summarizes this relatively new research perspective by stating that:

A critical reconsideration of the learning subject, i.e., the learner in school and in mathematics lessons, thus involves acknowledging the development of a fragmented post-modern self – multiple selves in different social contexts that change over time (p.77).

This means that each of the six girls in this study can assume different identities depending upon the social situation she experiences. It is difficult to broadly depict the girls’ mathematical identities in little more than a photograph, capturing them at a single point in time and in a single setting. These six girls’ mathematical identities are a function

of the setting they are in and according to Ernest (2004b) are shaped by conversation and evolve over time.

In this research, I have found post structuralism a productive theoretical lens through which to explore the on-going process of the ways in which six Grade 11 girls construct and negotiate their gender identities and gender relations in and through everyday practices, including those of the formal Mathematics and Mathematical Literacy curricula. It illuminates that the girls' relationships with mathematics are embedded within dominant ideas and discourses about mathematics. Its theories and methods offer ways of focussing on small, local stories about specific discourses and power relations.

Throughout this thesis it has been important to focus on discourses that bring gender and Mathematics into being. The discourse of "doing Mathematics is doing masculinity" (Bhana, 2005, p. 8) still has currency today in a country where women's and girls' involvement in Mathematics and science is actively supported and aggressively encouraged through a number of government policy documents such as the White Paper on Education (Department of Education, 1995) and initiatives like the Science Education Project in South Africa (Mthiyane, 2007). It is in and through these discourses that learners position themselves and are positioned relative to gender and Mathematics. At this point it is important to consider that the girls in this study have social and economic capital and therefore it is not simply about discourses, but also how they use these discourses which are contextually specific around issues of race, class, sexuality and gender. However, this economic and social capital is differential. How and to what extent each of these girls actively uses this capital remains uncertain. Nevertheless the inter-relatedness of these becomes critical when exploring gender and Mathematics in a South African context. Any research on gender and mathematics education in South Africa needs to be contextualised in order to capture the realities of the African social structure. It is now imperative to explore the research that has taken place in the South African context.

2.7. THE SOUTH AFRICAN CONTEXT

There is a very large international and rapidly growing area of work in gender and mathematics education, especially in the last 30 years lead and produced by the International Organisation of Women in Mathematics Education (IOWME). What is a limited, but emerging focus within this area of gender and mathematics education, is identity work deriving from girls' experiences of classrooms and schools and more so the link to sexuality and the body which is the contribution of this thesis.

Of significant importance in the South African context is the report put forward by the Gender Equity Task Team (GETT) that identified a number of obstacles preventing the transformation of the South African education system (Wolpe et al., 1997). The report highlighted that significantly fewer girls pursue and pass Mathematics at a secondary school level and even less progress to studying the subject at tertiary education or take up careers in these fields. One explanation provided by the report for this is that the image of Mathematics has been constructed as a male domain and that a girl's self image is one that precludes that of Mathematician. The recommendation made for gender equity was that education needed to consider where, how and why girls' experiences have been excluded from a field traditionally valued in education. Chisholm (2003) writes that the Gender Equity Task Team (GETT) provided path-breaking analyses in the South African context of what girls are accessing at schools. This thesis contributes to the South African literature by focusing on how girls in an elite independent school associate with Mathematics.

The GETT report does not make specific reference to girls in middle to upper middle income independent schools. Possibly this is because there is an assumption that, in light of the fact that these schools have access to improved facilities, resources and teachers, learners who attend these schools will automatically incorporate Mathematics positively into their identity projects and that all is well in terms of girls and Mathematics.

Chisholm (2003, p.7) documents that in recent times, gender in curriculum studies has been less concerned with the need for girls to change and recruiting girls into

traditionally male fields than with the curricular constructions of male and female subjectivities and identities. She concludes by commenting that little of these kind of analyses exist in the South African context.

What has emerged, however, is a growing number of qualitative studies in gender and Mathematics education that have begun to problematise the inviolate position of mathematics (Vithal, 2002, 2003). These studies have focussed primarily on tertiary education and upper primary school. An exception to this is Bhana's (2005) study that focussed on seven and eight year olds. Bhana continues that while gender studies in Mathematics education offers some useful theoretical ideas in understanding the persistent masculinisation of Mathematics, the links between Mathematics education and masculinities [femininities] remain largely unexplored in the South African context.

Many of the quantitative studies in South Africa that have focussed on gender and Mathematics have had the specific aim of assessing the academic achievement and ability of girls and boys in terms of their performance in the Senior Certificate Examination (Khan, 2006; Perry & Fleisch, 2006; Reddy, 2006). The results from these studies are then predominantly used to examine the quality of educational programmes.

There are very few qualitative studies in the South African context that focus specifically on girls in the first instance and in the second instance on the construction of girls' identities in relation to Mathematics in the secondary school. Mthiyane's (2007) study focussed on the various factors that contributed to the success of African girls in Mathematics and science in both single-sex and coeducational schools in KwaZulu-Natal.

Further research into the sociology of Mathematics has illuminated various shortcomings in pedagogical practices in South Africa. The new South African curriculum implores teachers to realise a pedagogy in their classrooms that is more practical and activity orientated and connected to the lives of their learners. However, according to Vithal (2002; Vithal, 2005) who researched the teaching of Mathematical measurement in

the primary school, this seemingly innocuous activity was found to be deeply gendered and this resulted in various levels of participation and resistance. She argues that 'bringing the everyday' into the Mathematics classroom serves to deny access to Mathematics itself. When relevance is increased by connecting Mathematics to learners' lives gender needs to be addressed in the Mathematics classroom. The difficulties faced by "girls in participating equitably in Mathematics classes are likely to increase unless concerted efforts are made to effect change in actual implemented curricula, teaching material and teacher education programmes"(2002, p. 119). In this study, Vithal also found that in group work, which appears to have become synonymous with Outcomes Based Education here in South Africa, boys completely dominated activities when working in mixed-groups. In concurrence with this, Bhana (2005; Vithal, 2005) also found that group work in Mathematics functioned as a key site both for the gendered display of hegemonic masculinity and for the subordination of others.

Bhana (2005) in her study of seven and eight year olds provides an important framework for understanding how learners become active agents in shaping their identities. In this research she examined how boys experience the concept of 'hegemonic masculinity' in which the real expression of masculinity is embedded in elements of power and prestige, all of which affect girls in inequitable ways. She documents how the association with mathematics is centrally about identity and doing mathematics is a key site where young people make themselves. An important recognition made is that constructions of masculinities vary with what it means to be male according to different times and places. The note on which her article concludes: 'doing mathematics is doing masculinity', leaves open the question as to how school mathematics can be practiced outside the scope of 'hegemonic masculinity'.

Vithal (Vithal et al., 2005; Vithal & Gopal, 2005) who has contributed a considerable amount to research on Mathematics education in a South African context, provided insight into an emerging field of research referred to as reform research in Mathematics or policy study. Reform research by definition is concerned with change and

as such the set of questions that reform research must engage is related to change of the “whole complex of students, teachers, researchers, parents, and politicians” (p.46). She continues that arguably the main focus of this work in both South Africa and elsewhere has been on teachers. Yet, if education is, in the final analysis, about learners and what learners gain and take away from the curriculum, then one would assume that research should focus on learners’ views and perspectives. Harley & Wedekind (2003, pp. 3-4) state that “the learners’ experiences of classroom practice is the dimension of C2005 most poorly served by research”. They identify a gap in their review of research in this area that “learners in the learner-centred system have been displaced from the gaze of research”. This is ironic in light of the fact that one of the key design features of the new South African curriculum is learner-centredness. It is important to point out that although I am drawing on literature surrounding reform research, this study which draws on poststructural feminist theories, cannot be classified as reform research because according to Francis (2005, p. 20) “that while useful for critique [poststructuralist positions] they are unable to [and are even opposed to] contribute to the political and emancipatory work needed for change”. However, it is important to note that there are many who would disagree with Francis. However, what I find helpful in this literature is that it is essential for the voices and experiences of the learners to be researched, particularly within the new FET curriculum which like OBE emphasizes learner-centredness. The focus on learners, what they say, feel, think and do, beyond assessment measures is increasing and needs further exploration. (Jeffrey, 2003; Pollard, Triggs, Broadfoot, McNess, & Osborn, 2000).

Vithal’s (2004) work on the identities of street children in relation to the Mathematics classroom also provides an important reference for this thesis in that I draw from her research into how these children develop their own identities within a particular sub-culture. She elaborates on how children participate in the Mathematics classroom and continues that even though this community of the Mathematics class may fragment along other lines of community such as age, gang alliances, geographic urban-rural home etc., for the period that these children are in the Mathematics classroom, they are participating in a particular social world that collides and coincides with these different identities. Although

the six girls in this thesis are a far cry from street children and from the suffering associated with this lifestyle, I nevertheless find Vithal's argument about identities colliding and coinciding in the Mathematics classroom particularly interesting and pertinent to this study.

It is necessary to state that there are in fact moves being made towards understanding Mathematical practices, how these are interpreted into curriculum reform, and its potential to intersect both positively and negatively with issues of equity and social justice. However an interrogation of this goes beyond the scope of this thesis.

2.8. Conclusion

In this chapter, I have argued for taking a poststructural view of gender, focussing on the ways the girls in this study actively negotiate, construct and contest gendered identities in everyday action. The literature reviewed here, highlights that the identities of the girls in this study intersect with issues of race, class, sexuality and are inextricably connected to their experiences and doing of mathematics. I have explored the idea that the construction of femininity and masculinity takes place within a heterosexual matrix, drawing on Butler's (1994) concept which she defines as a grid of cultural intelligibility through which bodies, genders and desires are naturalised. In particular, I have utilised Butler's (1994) notion that identities are "performative" and "permanently problematic" and thus the idea that "gender" is not something that one "is" or "has", but something continually created and recreated through everyday social and cultural practices. In Chapter 3, I present the methodology used to explore the various ways that the girls in this study actively produce, perform and negotiate their identities whilst engaging with the Core Mathematics or Mathematical Literacy learning areas.

CHAPTER 3 METHODOLOGY

3.1. INTRODUCTION

This research explores the ways in which 2 Indian and 4 White Grade 11 girls from an independent, predominantly middle to upper middle-class Catholic school construct their relationship to Mathematics. There is little qualitative research in the mathematics education literature that informs “the evidential facts that girls choose mathematics less than boys and that gender disparities in achievement prevail at some levels” (Boaler, 2000, p. 39), and even less that approaches this through an exploration of the identities of learners doing mathematics.

This chapter presents the research design and methodology selected in answering the following key question:

How do Grade 11 girls in a Catholic coeducational independent school construct their relationship to the learning areas of Mathematics and Mathematical Literacy?

In answering this question, the following two sub-questions will be answered:

This relationship is constructed by:

- How do they see themselves in relation to Core Mathematics or Mathematical Literacy?
- What are their gendered experiences of Core Mathematics or Mathematical Literacy?

The question of how the girls “see themselves” is an identity questions and draws attention to the various ways each girl positions herself relative to Mathematics and Mathematical Literacy, the second draws attention to their experiences both inside and outside of the classroom environment. In this thesis, identity and experiences are focal points as they are important in mutually co-constructing the girls’ relationship to Mathematics and Mathematical Literacy.

To accomplish the goals of the study and to adequately answer the research question, several methods of data collection were employed. This is in keeping with the contention

of Henning (2004) that the group of methods chosen must be coherent and represent a good fit in order to deliver data and findings that suit the research question. The first section of this chapter presents the research approach selected and the latter sections present the process of data collection as well as that of data analysis.

3.2. THE QUALITATIVE, INTERPRETIVE APPROACH

In an attempt to get a depth of understanding of how each girl constructs her relationship to Mathematics I adopted a qualitative, interpretive approach. At this point it is necessary to highlight the features of this approach and why it is suitable for my study as opposed to a quantitative approach.

Over the years, social science researchers have disagreed on a number of issues regarding the purpose of social research as well as appropriate methods to study the social world. The dominance of the ‘scientific method’ in the early 1930’s led to social scientists adopting it to make sense of human behaviour. However, over the years, “social science researchers began to challenge the view that the social world is like the natural world, and that there are a series of laws that can be discovered and that hold true across the universe” (Mthiyane, 2007, p. 55). Hammersley & Atkinson (1995) write that this dissatisfaction led to the emergence of two conflicting paradigms: namely, positivism, which advocated the use of quantitative methods, and the interpretive approach which promoted the use of qualitative methods to study the social world. Mthiyane (2007) writes that it is important to note that there is great diversity within the interpretive approach, but the common thread running through these methods is the rejection of the positivist’s view of conducting social research.

Positivism advocates the use of scientific methods operated on the physical science. Theories that are generated by scientific methods are constantly put to test, where they are either confirmed or disputed. The quantitative methods employed in collecting data are presumed to be objective, free of researcher bias, controllable and capable of replication. Experiments and surveys are the most widely used methods of data collection, and the data

generated is analysed using quantitative methods. A key feature of positivism is that it searches for universal patterns and laws that are generalisable across all circumstances.

In opposition, the qualitative approach may be described as a “generic approach in social research according to which research takes as its departure point the insider perspective on social action” (Babbie & Mouton, 2001, p. 270). This approach focusses on the importance of listening and is concerned with seeing the world from the perspectives of the research participants. It puts the individual at the centre of the research process, and views people as actively constructing their social world, giving personal meaning to their situations and events, and making informed decisions to act in particular ways. According to Mthiyane (2007) the role of the researcher is to understand the individual’s interpretation of the world, rather than to impose the researcher’s interpretation on the individual. Cohen, Manion, & Morrison (2000) pen that the qualitative approach challenges the belief that there are universal laws that govern human behaviour, and that these laws can be discovered by an objective, detached researcher, using neutral methods of data collection.

I found the qualitative, interpretive approach suitable for this research because the aim of the research was to understand the ways that Grade 11 girls in a Catholic private co-educational school construct their relationships with Mathematics. This meant studying these girls in their ‘natural’ school environment rather than under artificially created conditions. I also wanted to understand what participants did and the meanings that they attached to their actions. The interpretive framework was the logical choice for this study as it is not concerned with producing generalisable laws, but rather aims to produce thick descriptions that emphasise interpretation and deep understanding. It is important under the qualitative approach that “thick descriptions” (Henning, 2004) of conceptualised behaviour be documented. The purpose of this study was also not to make any generalisations or to arrive at an absolute truth, but rather to gain a deep understanding of the Mathematical stories generated in this specific school environment all the while acknowledging multiple realities from different perspectives.

In addition to the interpretive approach, I borrowed from poststructural feminist research approaches (Mendick, 2004, 2005a, 2005c, 2006; Paechter, 2001b) in my study and therefore employed methods and methodologies that would theorise the identities of the participants as fluid, contradictory, transforming and relational. I took cognizance that there is no knowledge beyond or outside of relations of power. Drawing on a feminist research approach that rejects positivism, I put gender and other social divisions such as race and class at the centre of my research process and understood these divisions as inequalities of power. Mendick (2006) writes that at the centre of feminist critiques is the need to acknowledge the situatedness of the researcher and to reject the goal of objectivity that the knower should detach themselves as far as possible from the situation they are studying. It is important that I, as a white, thirty-four year old, middle-class, female teacher take cognisance of my role as researcher in the study, and the effects that my research may have had on both the participants and myself. Drawing on feminist research requires that I acknowledge the use of a multiplicity of research methods in this study in order to expand on the existing body of knowledge on gender and Mathematics by seeing things differently and in a different context.

The research methodology that I employ in this research will be that of narrative analysis, which “may be seen as a specialised form of discourse analysis because it searches for the way participants make sense of their lives by representing them in story form” (Henning, 2004, p. 122). Central to poststructural theory is discourse. Discourses are structures of language and practice through which objects come into being. They are knowledges about objects which are powerful because they determine what can be said about something as well as who can say it. In the next sections I describe the process of data collection and analysis.

3.3. THE RESEARCH PROCESS

3.3.1. Selecting the school

I conducted my research at a Catholic, independent, predominantly middle to upper-middle class, coeducational school situated on the Ridge in Durban. In this study I shall call the school, Glenville College, a pseudonym to protect its identity. I refer the reader back to the introductory chapter where I described the research site in detail.

The decision to conduct my research in this particular school was based on three factors. Firstly, Morrell (1992) argues that simply removing the barriers to girls' education cannot account for the problems that girls face in schools and that the understanding of gender and education must move beyond equal access to education and focus more on the quality of the education received by the girls. The barriers towards education that Morrell highlights have, as far as possible, been removed in the researched school and the girls have access to the same resources, teachers and opportunities as the boys. My appointment as Head of Department at Glenville College with a specific portfolio to look after the interests of the girls in the school attests to this. My responsibility is to ensure that the girls are given an equal opportunity to develop their full potential in the classroom, on the sports fields and in the cultural arena.

Secondly, a substantial amount of literature exists that supports the argument that girls make more progress in mathematics in single-sex rather than coeducational schools (Hannan, Smyth, McCullagh, O'Leary, & McMahon, 1996; Smith, 1994; Tsolidis & Dobson, 2006; Van de Gaer, Pustjens, Van Damme, & De Munter, 2004). This was of particular importance to my research as the school has enjoyed co-educational status for the past 12 years, and in that time no one has explored the mathematical progress that the girls have made thus far. Glenville College was suitable because I was looking for a research context that would enable me to collect data that I could use to create new mathematical stories.

Lastly was the issue of feasibility. Gaining access to the research site and the participants was relatively straightforward as I have taught in the school for the past 13 years and have a good working relationship with the Principal, my colleagues in the Mathematics department and the Grade 11 girls. It was relatively simple to collect data as I had access to the participants in the study on a daily basis and did not have to spend time travelling to another research site to collect data. Given that I am a novice researcher and the anxieties I had about doing research, a familiar context would help me feel a little more comfortable with the entire process.

3.3.2. Gaining access to the school

Gaining access to the school was relatively straightforward and in September of 2006 I drafted the college principal a letter (see Appendix 2) stating that I was pursuing my Master's degree specialising in gender and education with a particular interest in the area of gender and mathematics. I explained to him that I was interested in conducting research in the school for the various reasons mentioned above and supplied details of the methods that I intended to use and that the participants would be selected from the Grade 11 girls. I also provided my supervisor's details for him in the event that he wished to contact her to discuss this research further. Being an academic himself (he had obtained his PhD in 2005) the College Principal was enthusiastic about my request and gave me his written consent to continue (see Appendix 3). However, he stipulated in this reply that the research was dependent upon the willingness of the individual teachers to participate if and where necessary. Being an independent school, I was not required to seek permission to conduct research from the Department of Education.

I met frequently with the college principal to keep him up to date with the research and to discuss certain aspects of it with him. I met with him on one specific occasion to discuss using a suitable pseudonym for the school in order to protect its identity. He was adamant in his decision that I was not to use a pseudonym and that I was to use the school's full title. I got the distinct impression that he was proud of the fact that the school was being used for academic research purposes and asked me to share the findings of this

research with the school's board of administrators after I had completed it. This posed a problem for me because in my application for ethical clearance, I had stated that I would use a pseudonym for the school in order to protect its identity and that of my participants. I decided that I would consider this in more detail after discussing it with each of the participants.

3.3.3. Gaining access to the teachers

Having taught Mathematics at a Grade eight level only over the past eight years, I developed a fairly comfortable working relationship with my three male colleagues in the Mathematics department. I am the only female in the department. I approached all three teachers and explained to them that I was interested in conducting research on the girls in the school and that I was specifically interested in the ways that the girls constructed their relationship to Mathematics and that the focus of my research was the girls and not them or their teaching methods. All three teachers were very accommodating and said that they were happy to allow me into their classroom to observe at any time. I then drafted a letter (see Appendix 4) to each of them requesting permission to observe during their Grade 11 Mathematics lessons, and provided them with some tentative dates. Mr Berkowhizz was the only one of the three teachers who expressed any sort of interest in my research and we engaged in regular discussions regarding girls and mathematics, his experiences and ideas, gender issues and my research.

3.3.4. Selecting the participants

Selecting the participants proved to be far more challenging than gaining access to the school. Drawing from purposive sampling, the selection of six Grade 11 girls was deliberate as they "fit the criteria of desirable participants" (Henning, 2004, p. 122) and fit the needs of the inquiry. They were suitable as they were the first intake of girls into the school, and would have already experienced one year of the new Mathematics and Mathematical Literacy curriculum under the Further Education and Training Band that stresses learner centredness and the development of skills, knowledge, attitudes and values. I decided to work with three girls out of a possible nine from the Core Mathematics group

and three girls out of a possible eight from the Mathematical Literacy group in order to gain an understanding of how the different classroom environments and curricula may influence the construction of Mathematical relations. In selecting these participants I tried to strike a proportional balance between the number of White and Indian girls in the grade and school as a whole. I am aware that the selection of Black girls as participants could have the potential to deepen the analysis and findings of the study. However, at the time of this research there were no black girls in this particular grade that could have been selected as participants.

Mendick (2004, p. 33) argues that “there is no simple relationship whereby increasing the sample size of a study necessarily makes it a more worthwhile piece of work”. My aim was depth over breadth in my research and participant selection was not about population representativeness, but was rather meant to understand how these girls in this specific school context construct their relationship to Mathematics.

In February of 2007, I asked all the Grade 11 girls to meet with me in the audiovisual room in the school’s Learning Resources Centre. In retrospect, this was not a good idea, because in the past when I called the girls together for a meeting it was usually to discuss some disciplinary issue that had arisen, and so, knowing this they arrived very tentatively for the meeting. At the outset, I explained that this meeting was not to reprimand them or to discuss any discipline issues with them, but was for a personal reason. I explained to them that I had been studying for the past three years towards my Honours and Master’s degree and I had reached the stage where I had to start my research. I explained that I was interested in exploring how girls constructed their relationships with Mathematics. I took time and care to explain to them what participating in the study would entail and that they were under no pressure to participate. I tried as far as possible to reassure them that if they chose not to participate it would not influence my relationship with them or jeopardise their future at the school in any way. It would have been foolish of me to naively believe that my status as Head of Department and teacher did not have any influence on their decision to participate or not. In closing the meeting, I asked the girls to

go home and think about it, and to either write to me or come and tell me if they decided they did not wish to participate.

Only one of the seventeen girls came to me to excuse herself from participating in the study. I was interested in finding out her reason why and asked her to write down the reasons for her decision and slip it under my office door, which she did. The following extract is taken from her letter:

Dear Mrs Vermeulen

...I felt that I might feel intimidated knowing that someone would be watching me during maths lessons. Due to that feeling, it could cause a lack of performance of my ability during maths lessons (see Appendix 5).

Cohen et al. (2000) caution educational researchers against ignoring children's rights to refuse participating in a study and as much as I would have like this learner to participate, I had to respect her right to refuse. Her reason highlights what Gay (1996) identifies as one of the most important rules of ethics in research, which is ensuring that subjects are not harmed in anyway either physically or mentally in the name of science. In education, one of the types of harm that can be done to the participants is to retard their learning in any way. My ethical responsibility was to ensure that none of these girls were placed at risk educationally. Other guidelines to ethical research include getting informed consent from both the participants and their parents, explaining the purpose of the research, the methods of data collection to be used and how the data will be stored and disseminated.

3.3.5. Dealing with the unequal power relations between researcher and participants

Having taught most of these girls at one or other time over the past four years, I had developed a good rapport with them, which is essential for in-depth qualitative research. I thought that dealing with the unequal power relations between them and myself would be relatively simple. However, unequal power relations continue to exist between teacher and pupil not matter how good the rapport between them is or how hard one tries to balance or diffuse them. This presented the biggest challenge as I tried very hard to untangle the

networks of power that existed between myself as researcher and them as participants and myself as a teacher and them as learners.

I decided to invite (see Appendix 6) the six participants out to an 'ice-breaking tea party' in the neutral environment of Mitchell Park in Durban. The park has beautiful botanical gardens and a bird park and the atmosphere here is informal and relaxed. My primary aim in having this meeting was to spend some time with the participants informally to develop their confidence and trust and to build on the rapport that I already felt I had with them. Secondary to this, was to explain to them in detail what their participation in this study meant, the concept of informed consent, confidentiality and anonymity, the data collection methods, how the data would be stored and what I planned to do with the data. Lastly, but possible of greater importance than the previous two reasons was to tell them my own story of why I was conducting this research and why it was so important to me. I also hoped that by sharing my personal story with them, I would allow them into my world and this may bring about some balance in the unequal power relations between us. I told them about my childhood and my school experiences and showed them some photographs of me. I spoke to them about my family and showed them some photographs of them. I wanted the participants to see me in a different context and not only in my professional capacity and I wanted them to feel comfortable enough with me to allow me into their worlds. They asked me a number of different questions which I answered as honestly as possible and shared some very personal information with them. At this point I felt very vulnerable and realised that power did not just rest with me: most of the power rested with them. I gave each participant and their parents a letter explaining exactly what their participation in the research entailed and asking for their informed consent (see Appendices 7 and 8). I included my contact details and those of my supervisor on the letters in case either the parents or one of the girls needed to contact us for further clarification on any of the issues mentioned or simply to discuss the research in more detail. I signed the letters informally, just using my first name. All six participants and their parents gave their consent.

Reflecting back on this event, I was satisfied with how this ‘tea party’ had progressed and felt that I had made some inroads into getting the girls to feel comfortable with me. However, I acknowledge that the power relations away from the school environment are very different from those in the school environment, as we all take on different identities in different environments.

3.4. METHODS OF DATA COLLECTION

The use of different techniques to collect data provides a basis to check validity by analysing data relating to the same issue from different sources. In order to ensure what Hammersley and Atkinson (1995) call “technical triangulation”, this study primarily used semi-structured in-depth interviews and to a lesser degree semi-structured observations, participants’ journals and an analysis of some documents.

3.4.1. The interview process

With the emphasis on learners’ identities, it seemed that interviews would be the most direct way to access these. I view the process of interviewing,

as not simply about the giving and receiving of information but at least as much about speaking identities into being, solidifying them and constantly reconstituting them through the stories we tell ourselves and each other (Epstein & Johnson, 1998, p. 34)

Feminists have written a great deal in an attempt to theorise the role of the interviewer and the focus of this work has been power, understood in terms of the relative positioning of the interviewer and interviewee within social structures, notably those of gender, class, age and race. In research focussing on gender it is significant that I am a woman and Finch (1993, p. 35) argues “that in woman-to-woman interviews, the fact that both parties share a subordinate structural position by virtue of their gender makes a special interview relationship possible”. It was unavoidable that I took my age, race, professional position, class, gender and bias into every interview.

I sent out letters to each participant three weeks prior to the week in which I wished to conduct the interviews. The letters detailed the time, date and venue of the interview (see Appendix 9) and I asked each participant to ensure that this specific date and time suited them and did not interfere with any extra curricular activities they were committed to. This was important as I had undertaken as far as possible not to disrupt their educational programme in any way. I refer the reader back to the introduction chapter for full details of the six participants aged between fifteen and sixteen. The interviews varied in both length, ranging from twenty five minutes to fifty minutes, and in formality.

I decided to conduct the interviews in the Learning Resources Centre, away from the main academic buildings and all but one of the interviews was conducted there. My reason for conducting the interviews here was that this was the most neutral, environment in the school and there was a small sound proof room that could be utilised without risk of interruption. One of the interviews I conducted in my classroom as the centre was closed for the day and I did not have an alternative venue. I was reluctant to use my own classroom or office as these are my personal spaces and I was conscious of making the participants more uncomfortable than was necessary. In retrospect, the room I chose did not present a very warm or attractive environment as it was sparsely furnished and the walls were bare. In each interview, both the participant and I sat informally on the arc of a round table, with a comfortable distance between us. We faced each other and placed the tape recorder between us. This seemed to be the most comfortable and informal way to conduct the interview. I did not want to sit at the square desk as I would be facing the participant directly and as it was, the room felt very clinical and sterile and I did not want these interviews to resemble an interrogation.

At the start of each interview, I reminded each of the girls that their participation in the study was voluntary and that they were free to withdraw at anytime if they so wished. Ensuring confidentiality and explaining to the participants how their anonymity will be maintained are crucial for an ethical research process, and I explained this in detail to each of them. However, when I suggested the use of a pseudonym as a means of ensuring

anonymity five of the six participants firmly stated that they wished to use their own names as “they were proud of them”. The other participant was ambivalent and said that either way she did not really mind. One of the participants expressed a concern that her teacher would have access to the audiotape of the interview and I assured her that under no circumstances did anyone other than myself have access to the audiotapes. She accepted my assurance and happily continued with the interview. It was at this point that I decided not to use the real name of the school, although the principal had been adamant that I should. Although the girls had given me permission to use their names, I was concerned that they were not making an informed decision and did not really understand the depth of what the consequences might be. I could not be certain about offering them protection once this research had been made public. I felt that I had an obligation to protect the identity of my participants and that meant hiding the identity of the school and them, although complete anonymity would be difficult and almost impossible to achieve as I teach in the school.

The interviews were semi-structured (see Appendix 10) and I felt this was suitable as this type of interview allows for a greater depth that is otherwise difficult to attain using other methods. They allow the researcher to probe answers and to involve the participants more in the interview process. I explained that there were no right or wrong answers to any of the questions, but that I was interested in hearing their thoughts, ideas and opinions. Semi-structured interviews also allow for more flexibility during the interview process for both the interviewer and the interviewee and my aim was to facilitate and guide the interview process rather than to control it. I decided that writing while the participant was talking would interfere with the conversational quality of the interview and would be a distraction for them and inconvenient for me as I would not be able to give her my full attention. I decided to tape the interviews as I felt that this would enable me to record the interview whilst being fully involved in the interview itself. Recording the interviews would allow me to transcribe them at a later stage and I could return to the taped interviews many times in order to get the full picture of what was shared in the interviews. I explained this to each participant and they all granted me permission to tape the interviews.

The interviews started with very broad questions about the participants' experiences in their mathematics classes, exploring what they had enjoyed most and least both this year and last year, narrowing the focus down to more specific questions about the participants' families. By starting with this broad question, it gave the participants a chance to direct the interview, although I was mindful of the danger of moving away from the focus of the interviews and collecting data that would not be of benefit to my research. Once the interview was complete I thanked the interviewee for their time and valuable contribution, highlighting that without them this study would not be possible. I undertook to show each participant and their parents the findings of my study once it was complete.

I was satisfied with all but one of the interviews. The participant arrived ten minutes late and throughout this interview it felt as if I was painstakingly extracting information from her and she often responded in short answers even when I attempted to probe further. Her interview was characterised by a number of "I don't know responses" interspersed with long pauses and sighs. I noted after she left that it appeared as though she was regretting her decision to participate in the study. This showed me that power pervades the interview and that power, although disproportionately on the side of the researcher, is not fixed there.

The participants and I collectively planned a debriefing session and this took the form of an informal dinner at the end of the year. The research findings were shared and a discussion ensued around the participants' feelings, involvement in and general thoughts about the research process and findings. I also discussed my feelings and thoughts about the entire research process with them. The participants offered some very insightful comments about the structure of the interview process and ways in which I could have improved on this. Collectively they agreed that they had enjoyed being part of the research process and looked forward to reading the findings of the study. I then offered them the opportunity to read the complete thesis when it came back from the examiners and I had made the necessary corrections. According to De Vos (2002, p.73) debriefing sessions are essential as the participants "...get the opportunity, after the study, to work through their experiences and its aftermath, [and this is one possible way] in which the researcher can assist the

[participants] and minimize harm”. The easiest way to debrief participants is to discuss their feelings about the study and to explain to them that the study should have been a learning experience for both them and me. De Vos (2002) states that the debriefing session is the ideal time to complete the learning experience that began with agreeing to participate.

3.4.2. Observing lessons

Observation in qualitative research has been labelled either as participant or non-participant, depending on the level of participation of the researcher in participants’ activities. Cohen et al. (2000) argue that in participant observation, the researcher fully participates in the activities that she plans to observe and is regarded as a member of the group. A non-participant observer, on the other hand, is detached from the participants and does not participate at all in their activities. Mthiyane (2007) classifies the role of the researcher in observation as lying on a continuum, from complete participation, to participant-as-observer, to observer-as-participant, and finally to complete observer. My positioning on this continuum continually shifted over the four roles during the observations, I however found myself spending more time in the roles of complete observer and observer-as-participant.

My observations were semi-structured, and sometimes unstructured (see appendix 11), as I tried to write ‘thick descriptions’ of what was happening in the classrooms. There were issues that I had identified before starting my observation but these did not restrict me from collecting data about other issues that emerged that I thought relevant to the study. I used the following framework to guide my observations: the physical setting of the classroom, seating arrangement of learners, resources used during the lessons, who participated in the lesson and who did not, the routine followed in the class, the teacher’s movements during the lesson, what relationships existed in the classrooms, how time was used, methods of teaching, content covered, pace of the lessons and what feelings were communicated during the lesson. I also paid careful attention to how the participants talked about gender and how they responded to any gendered comments made by fellow learners and the teachers. I made a point of going into the classroom five minutes before the learners

came in and I sat at the back between the learners, as I felt that this position would allow me to observe what was happening without feeling like I was imposing on the classroom dynamics.

I conducted six observations in total over a period of two weeks. Each observation lasted one hour, the duration of a double lesson. However, the time I could spend conducting observations was restricted by my own teaching timetable, and by the fact that I only had a three week period available before the learners began their mid-year examinations. The Grade 11 Mathematics lessons seldom coincided with my free lessons and I had to put in a request for a replacement teacher to sit with my own classes while I conducted the observations. I was acutely aware that by doing the observations during my teaching time, I was renegeing on the commitment I had to my other learners.

These administrative hurdles were relatively simple to overcome, but what proved to be a greater challenge is what De Vos (2002) refers to as the Hawthorne Effect, which states that people's behaviour may simply change because they are being observed as part of a study. With the naivety of a novice researcher I thought that I had taken sufficient steps to put the participants at ease with my presence in their classrooms. I was wrong. The reality of how difficult observation was going to be was highlighted during the first Core Mathematics lesson I observed. I present the following extract from my observation schedule and field notes:

Mr Berkowhizz is revising quadratic equations. The learners were taught this last year in Grade 10. He is questioning them on how to solve for the value of x and the class and I are sitting quietly listening and watching him. Suddenly he bellows out "God dam it Mrs Vermeulen this is the very last lesson you are coming to observe, these children are too terrified to answer anything!" I smiled quietly at him and put my head down trying to make myself as invisible as possible. Both Mr Berkowhizz and the learners laugh at this.

I ignored him and came back the next day. I also made a fundamental mistake in that I observed the first two participants on the same day that I had scheduled to interview them and so they were acutely aware that my presence in the classroom was to observe them and this heightened their discomfort. I rectified that by rescheduling the remaining observation

lessons. Another limitation of observations was brought to my attention at the end of an observation lesson in the Mathematical Literacy classroom. Mr Schekter, the teacher, asked if the lesson he had presented had given me what I needed. He offered to create situations for me by placing the learners in groups and getting them to be creative if that was what I wanted. I thanked him for his willingness to contribute to this study, but assured him that the lesson was perfect. I explained that I simply wanted him to continue in a normal manner and try to ignore my presence as far as possible.

I was not using observations in an attempt to get closer to the truth, but my main aim with the observations was that it would allow me to work with a notion of discourses as structures of practice rather than just structures of language (Mendick, 2004; Paechter, 2001b; Weedon, 1997). The observation would allow me to see identities in practice in relation to others in the immediate context of their Mathematics lessons. Mendick (2004) expresses a concern that many previous research studies that have investigated gender relations in Mathematics have not researched the teaching environments in which students were working.

I attempted to type up the notes from my observations as soon as possible after the experience, but given my other commitments this often proved to be more difficult than I had anticipated. I then worked through these notes and identified and classified incidents according to themes that emerged from the data. Owing to the time constraints, I was not able to spend lengthy periods of time in each classroom. This would have given the participants and the other learners time to adjust to my presence and begin to see me as part of the group and not as an outsider, thereby lessening my impact on the data collected.

3.4.3. Document analysis

In addition to interviews and observations, I also used non-human sources, which Cohen et al. (2000, p. 111) argue “have the attraction of being always available [and] often at low cost ...”. My insider status at the school also meant I had unrestricted access to the quarterly schedules containing the marks that every student had obtained in each subject

since their Grade 8 year. Although as I mentioned previously the focus of this study is not on achievement in Mathematics, these provided a good starting point and backdrop to the study. The purpose of analyzing the schedules was to try and supplement the information that I collected using observations and interviews in order to provide a broader background for each participant's story.

3.4.4. Participant journals

I gave each participant a journal at the 'ice breaking tea party' that we had at the start of the research process. They were small A5 booklets which I had covered and printed their names onto. Reflecting back on this, it only occurred to me much later that I had covered the three journals for the girls in the Core Mathematics group in purple paper and the three journals for the girls in the Mathematical Literacy group in pink.

By asking the participants to keep these journals, I was hoping that any incidents that occurred in their Mathematics classes outside of my observation lessons and that they deemed important, could be documented. And if they had been reluctant to answer a question in the interviews they may have felt more comfortable writing these in the journals I had provided. I also wanted them to use these journals to record any feelings, ideas and thoughts that they may have during the time they were involved in the research. "Journals are a powerful way for individuals to give accounts of their experiences" (Clandinin & Connelly, 2000, p. 102)

The journals were used with varying degrees of success through the month that the participants used them. However, two of the participants confided to me that they had forgotten to keep the journal, and had written up something quickly the night before I had asked for the journals back as they felt embarrassed giving them back to me empty. I tore out the pages that the girls had written on and gave the journals back to them to keep and to use as they saw fit. The purpose of analyzing these journals was to try and supplement the information that I had collected using observations and interviews in order to provide a broader background for each participant's story.

3.5. ANALYSIS OF THE DATA

I read through the transcripts of the interviews, the notes from observation and the data collected from the participants' journals and checked for incomplete, inaccurate, inconsistent and irrelevant data. I then listened to the audiotapes again and read through the transcripts and notes carefully in order to immerse myself in the details, understand the content of the data, and develop a sense of the participants' characteristic language usage (De Vos, 2002; Henning, 2004). I adopted a holistic approach to analysis that involved writing up a story for each participant as I believed it would be more productive to examine the data collected on each participant as an integral whole. This would allow me to look at both contradictions and consistencies within the six stories. After I had completed the individual stories, connections between them were used to identify possible themes for further analysis.

By using stories, I made an attempt to capture the way these girls, through a complex process of negotiation and identification, position themselves relative to Mathematics. Mendick (2004) believes that experience exists through our attempts to make sense of it by telling stories. And according to Winterson (1985, p. 93) "everyone who tells a story tells it differently, just to remind us that everybody sees it differently". Clandinin & Connelly (2000, p. 2) write that "the term *experience* helps us think through such matters as an individual child's learning while also understanding that learning takes place with other children, with a teacher, in a classroom, in a community,...". I chose to present my findings and analysis of the data together as I felt this made for a clearer and more cohesive argument.

3.6. TRUSTWORTHINESS AND TRANSFERABILITY

Mthiyane (2007) argues that the nature of qualitative research does not make it possible to establish a completely valid study, but that there can only be notions of validity. However valid studies are possible in qualitative and feminist research. Qualitative work argues for transferability rather than generalisability precisely through the kind of "thick descriptions" provided in the study. The interpretive nature of qualitative research puts

people at the centre of the research process, and privileges their constructions of the world above those of the researcher. The role of the researcher is to capture people's interpretations, and what seems to be true for them.

My study aims to provide an in-depth description of the ways in which six Grade 11 girls from a Catholic, independent and co-educational school construct their relationship to Mathematics. De Vos (2002, p.351) argues that, "an in-depth description showing the complexities of variables and interactions will be so embedded within the data derived from the setting that it cannot help but be valid".

I also employed methodological triangulation which refers to the use of more than one method of data collection. Triangulation is a validity criterion and procedure. This method results in different types of data from different angles. I used interviews, observations, document analysis and participant journals in an attempt to try and understand the ways that each girl constructed her relationship to Mathematics. The data from the observations and journals was triangulated against the data generated from the interviews. The data collected will be represented through short extracts incorporated into the stories to ensure that the participants' voices emerge as far as possible.

In my study, credibility was maintained through methodological triangulation, reflexivity through extensive field notes and the verification of the final stories by the participants.

3.7. CONCLUSION

This chapter has provided an account of the choice of research methodology used and the justification to choose the interpretive approach has been described. I have also provided details of the methods that I used for data collection, and traced the path of data collection from the first stage of negotiating access through to how the analysis was conducted. Throughout my account of how I did the interviews and observations, I have paid attention to the issues of power that pervaded the entire research process, both my power as a researcher and the need for me to take responsibility for this, and the fluidity of power within the practices that have made up this research. After the experience of conducting this research, I concur with the argument that the research process is not neat, and linear but rather that it is complex and needs flexibility and sensitivity.

In the next chapter I present my findings and analysis of the data collected at Glenville College.

CHAPTER 4 FINDINGS AND ANALYSIS

4.1. INTRODUCTION

This research explores the ways in which 2 Indian and 4 White Grade 11 girls from an independent, predominantly middle to upper middle-class Catholic school construct their relationship to Mathematics. This study illustrates how doing Mathematics is doing gender and furthermore how the association with Mathematics underpins identity work as the category 'girl' is lived out amongst sixteen and seventeen year olds. The chapter also shows how sexuality is embedded within the doing of gender and how doing Mathematics is not only doing gender but sexuality as well.

In this thesis I argue that the discourses that are most central to Mathematics construct it as 'hard', 'absolute', 'a proof of real intelligence', 'certain', 'objective' and that these discourses inscribe Mathematics as masculine and therefore make it difficult for girls to form a positive association with it. The girls in this study associate with Mathematics on two levels: that of Core Mathematics and Mathematical Literacy. It is further argued that they relate to Mathematics also in terms of the hierarchies and the power vested in each. The girls in this study do not simply reproduce the idea that Mathematics is masculine, but they work on this. The Core Mathematics girls use it to their advantage and craft out power for themselves. The Mathematical Literacy girls, although they rejected Core Mathematics, showed an enjoyment of Mathematical Literacy. However, because Mathematical Literacy has been constructed as 'easy mathematics' by learners and teachers means that these girls insert themselves in a subordinate way to the Core Mathematics girls.

The analysis chapter centres on the Mathematical stories of two groups of girls. Nadiya, Rehana and Juliet comprise the group of Core Mathematics girls whilst Chrystal, Abigail and Madison form the Mathematical Literacy group. The differential power ascribed to Core Mathematics and Mathematical Literacy is key in enabling differential gender power relations. By drawing upon the stories of the girls in these two different learning areas of Mathematics I show how they actively negotiate and strategize around Mathematics. As indicated, the girls in this study do not simply disassociate from or reject

Mathematics completely as there is evidence showing various levels of enjoyment and a need for success in it particularly for girls doing Core Mathematics, where doing Core Mathematics is also an investment in social and economic power.

However, it is clear that an overriding theme for all the girls was the masculinisation of Mathematics, which they rejected. I begin this chapter by looking at the general theme of how these two groups of girls negotiate Mathematics and show that because of its construction as a masculine domain, the girls in this study have found it difficult to form a positive association with it. By drawing from the data collected in semi-structured interviews, observations, field notes and participants' journals I then disaggregate the girls' experiences based on Core Mathematics and Mathematical Literacy showing how each group actively carves out positions of power and subordination for themselves in relation to other girls and boys. Further to this, I explore how these girls negotiate their sexual selves in relation to Core Mathematics and Mathematical Literacy. What this analysis chapter will show is that when each of the girls in this study relates to Mathematics, they do not relate to the learning area of Mathematics or Mathematical Literacy alone, but their relationship to Mathematics is embedded within social processes including sexuality, gender, race and class and these are actively acted upon.

I adopted a holistic approach to analyzing the raw data that involved writing up a short story for each participant as I believed this would be a more productive way of examining the data collected as an integral whole. By using stories, I am attempting to capture the way these girls, through a complex process of negotiation and identification, position themselves relative to mathematics. This method would allow me to look for contradictions and consistencies within the six stories and allow me to answer the question of:

How do grade 11 girls in a Catholic coeducational independent school construct their relationship to the learning areas of Mathematics and Mathematical Literacy?

In answering this question, the following three sub-questions will be answered:

This relationship is constructed by:

- How do they see themselves in relation to Core Mathematics or Mathematical Literacy?
- What are their gendered experiences of Core Mathematics or Mathematical Literacy?

The question of how the girls “see themselves” is an identity questions and draws attention to the various ways each girl positions herself relative to Mathematics and Mathematical Literacy, the second draws attention to their experiences both inside and outside of the classroom environment. In this thesis, identity and experiences are focal points as they are important in mutually co-constructing the girls’ relationship to Mathematics and Mathematical Literacy.

After completing the individual stories, connections between them were used to identify possible areas for further analysis. Some content analysis was employed to assist in comparing the stories and highlighting further areas that were of relevance to the research.

4.2. THE OVERALL RELATIONSHIP BETWEEN GIRLS AND MATHEMATICS

CV: *Which learning area is your favourite?*

Nadiya: History. I enjoy History and (laughing) I don’t enjoy maths.

Rehana: History. There’s no maths involved at all (laughing)

Juliet: English, it is open to more interpretation. In maths you ultimately get one answer.

Chrystal: Art

Abigail: Art, I’m more Arty, so ART is my expression.

Madison: History and Art. Art is more about your feelings, your anger, your hurt, your frustration, your happiness. It is not a theorem that you apply to get a perfect drawing; there is no way to have a right piece of art.

Each girl expressed the enjoyment of being able to have their own opinion and be able to interpret resource material in learning areas like History, English and Art in various ways. Most of them disliked the pressure that they experienced in Mathematics in terms of having to come to one final correct answer. This confirms what the literature (Becker, 1995; Boaler, 1997a; Paechter, 2001a, 2003a) states about girls finding that the single correct answer required by Mathematics is something unique to that subject and subsequently being constructed as ‘connected thinkers’. Connected thinkers prefer to use intuition, creativity, personal process and experience. In other subjects, girls can derive success from finding a variety of solutions depending on a multiplicity of factors. By contrast, boys have been constructed as ‘separate thinkers’ and they prefer to work with subjects that are characterised by logic, rigour, absolute truth and rationality. Francis and Skelton (2005) write that it has traditionally been the case that ‘the Arts’ have been constructed as the feminine, expressive and emotional realm, while conversely ‘the Sciences’ are constructed as masculine and rational. The binary dichotomy between the ‘feminine’ Arts and ‘masculine’ Mathematics produces power and lack. They continue that this dichotomy bears hierarchy in terms of the status attached to the subjects. ‘The Sciences’ are associated with masculine high status traits such as objectivity and rationality, while ‘the Arts’ are “relationally positioned as imbued with feminine attributes of emotion and subjectivity” (p.112).

CV: *Would you consider a career in Mathematics?*

Nadiya: Uh Uh (shakes her head to indicate no) I don’t like it, it doesn’t interest me. I don’t know, for me it’s always been like hard work. I have to work harder at it than anything else.

Rehana: Uhm (pause) I haven’t really thought about it (laughs)
No, I wouldn’t. I am more interested in the financial side of things. I am interested in financial engineering where, it is not financial mathematics, but more CREATING financial investment situations, not SOLVING them.

Juliet: Well not a complete no, more of a “no-ish”. I just don’t want to do a scientific or mathematical career. I wanted to write, because I am more of a qualitative than quantitative person. But I actually don’t know. Ooh, I would love to end up philosophizing about English.

- Chrystal:* (pause) (laughs) I don't think so. I want to go into a career of graphic designing.
- Abigail:* No mam (laughs), I wouldn't be the best person for the job. I am currently researching what I need to get into Rhodes University to do a Fine Arts degree.
- Madison:* No, never (laughs). I hated core maths. I dreaded every lesson; there was a sense of fear, sweaty palms and heart palpitations. No, I would love to do a degree in history or art or law.
- CV:* *So you would never come back and think about doing Mathematics?***
- Nadiya:* Unless I had to do it as a course in Marine Biology and that's the only time. Other than that I would never.
- Rehana:* I know I am going to have to do some financial mathematics for financial engineering, but that is ok, because it is getting me to my chosen career. I want something interesting, something that I will be passionate about. I don't want to be bored.
- Chrystal:* No, it is enough just to do it at school
- Madison:* Never (pause) if I needed to I would do a bridge year in maths and do my best so that I could get into a certain field if I had to.

The construction of Mathematics as hard, more difficult, masculine and ultimately rational, together with the status and power residing in the masculine has made it difficult for the girls in this study to form a positive association with it. None of the girls in this study expressed a desire to continue with Mathematics once they finished school if they were given the choice. However, Nadiya, Rehana, Juliet, Abigail and Madison clearly stated that they would be prepared to continue studying Mathematics after school only if it was part of the university degree necessary for their future careers. Chrystal was emphatic in stating that once she had written matric, she was finished with Mathematics for good.

Having discussed the overall disassociation that these girls have with Mathematics, it now becomes important to explore and differentiate between the two groups of girls, the Core Mathematics group and the Mathematical Literacy group. In doing so, I make reference to 'core girls' and 'lit girls'. It is possible for me to use these two expressions as this is how the girls themselves refer to each other. By disaggregating the data into these two groups I hope to show how 'core girls' harness the same power invested in Mathematics as masculine that sidelines women and girls, to show power for themselves. In doing so, they resist other less clever girls and boys. Thus whilst there is an overall and general disassociation from Mathematics, this is not automatic.

4.3. 'OH MISS 100%' – CORE GIRLS

The above title is taken from an interview with Rehana, as she referred to the comments made to her after she achieved 100% in a Mathematics test. This section deals specifically with the three Core Mathematics girls, Nadiya, Rehana and Juliet. Nadiya and Rehana are two Indian girls who come from upper –middle class families. Nadiya is an only child and Rehana is the oldest of four girls in her family. Both Nadiya and Rehana's families emphasise the importance of education and both sets of parents hold tertiary education degrees. Juliet is a White girl and is an only child from an upper – middle class family. Her family has a firm belief in holistic education and the family often travels overseas in order to expose Juliet to as many educational opportunities as possible. Her parents too hold degrees from tertiary institutions. Juliet was awarded an academic scholarship to Glenville College, which will run until the end of her Grade 12 year. All three of these girls hold positions of leadership as College prefects.

These three girls are 'clever' girls and have over the duration of their Secondary School career been placed in the following positions in the grade. Juliet has succeeded in being placed first in the grade since Grade 8, Nadiya second in the grade since Grade 8 and Rehana fifth in the grade. The grade consists of sixty-five learners in total.

It is impossible to simply assess the relationship that these three girls have with Mathematics based on whether or not they intend to pursue a career in the field of Mathematics. Therefore, it was essential to look at the journals I had asked each girl to keep in order to further illuminate the way that each girl related to Mathematics. The following extracts were taken from the journals that Nadiya, Rehana and Juliet kept:

Nadiya begins her journal with a picture of a crying face and beneath it she has written, “2nd in the grade but failing maths. I can’t believe I failed maths. I feel bad. I hate, hate, hate maths!!! She draws a big 34% beneath this. She has pasted a letter into her journal from Rehana, in which she tells Nadiya not to worry they can work harder next term.

Rehana begins her journal with a list of words she associates with mathematics. They include, Exciting, It’s hard, try harder, why???, money, reason. She continues with the following: I truly enjoy the subject but at times it is a pain and I tend to hate it and have a negative attitude towards it. I was really disappointed about my last term mark 64% (Rehana draws an unhappy face next to the mark). I want to work really hard in the 2nd term to at least get a ‘B’ or even better an ‘A’ for maths!

Juliet begins her journal as follows: I have just received some appalling maths test results, so perhaps this isn’t the best time to consider what I usually think of the subject. I have always enjoyed maths depending on what section we are covering. In general I find that I have mostly solid feelings about each of my subjects. I think that, because my area of interest and greatest skill is language and History, I tend to enjoy these subjects more and get better marks in them. Maths marks last term 67% - terrible but expected. However, this doesn’t actually disturb me that much. I know that maths is not really my area; therefore it doesn’t surprise me that my marks are low.

In their journals all three of these girls, have spoken about either hating Maths or that Maths was not really their “area”. However in contradiction to this hate they talk about, they also express an enjoyment of the subject. All three girls made reference to the marks that they were achieving in Mathematics and how these marks had the power to elate or disappoint them. Thus, Mathematics was a source of both anxiety and pleasure. Nadiya and Rehana, the two Indian girls, expressed the devastation they felt at their results and both stated that they are going to have to work harder to improve on these. By contrast Juliet, the White girl, states that she is disappointed, but not devastated at her results and she expected them to be low. Frequently throughout her journal and our interview she (Juliet)

made reference to the fact that Mathematics was just not her area. Not once in either the journal or interview did Juliet state that she would have to work harder to improve, quite the contrary she expressed enjoyment at the sections of Mathematics and other learning areas she could do well in without having to actually work very hard.

CV: *So if you really enjoy the section you tend to work and find it easier than if you don't really enjoy the section then it becomes hard work.*

Juliet: Or possibly it is the other way around if I don't have to work at it then it is fun. I think it is due to laziness, a condition from which I certainly suffer.

There is research which shows that explanations for performance (or lack of it) attributed to "ability" or "effort" are gendered (Paechter, 1998, 2001a)

What emerges from these journal entries is that the relationship that these three girls have with Mathematics is anything but simple. Their relationship is fraught with a mixture of enjoyment, hatred, disappointment, acceptance of lower academic results, non acceptance of lower academics results in Rehana and Nadiya's cases, excitement and distress as the following extract from Nadiya's interview shows,

CV: *You said that you failed maths last term, how did you feel?*

Nadiya: Aah, I felt terrible it's I've been schooling for 11 years it's the first time I failed anything (pause) it was terrible (pause) I am not a crying person and neither is my mom but we were like so emotional.

CV: *Do you think that it was worse because it was maths?*

Nadiya: Yes yes (pause) I remember myself in Grade two mam (long pause) you know we had those story sums like Jane takes two sweets and I used to (pause) like be wriggling on the floor screaming not to do those problems I used to throw tantrums cause I hated maths

However there is also research that shows that high performing girls choose sometime to "fail" Mathematics in order to gain social acceptance, especially by peers and boys (Renold, 2001b; Renold & Allan, 2006).

In the next section dealing with these three ‘core girls’ I shall explore how these girls negotiate mathematics and strategically draw on the power of being clever in Mathematics to carve out a prestigious position for themselves amongst their peers. I do this by looking at how these three core girls go about actively presenting a clever self, their status as hard-working, the power and prestige of Mathematics in terms of race and class and finally by closely analyzing Rehana’s statements with regard to heterosexual femininity and the power of Mathematics.

4.3.1 Presenting a clever self

CV: *What other learning areas are you taking?*

Nadiya: Double Science and History

Rehana: Physics, Accounting and History

Juliet: Physics, Biology and History

CV: *How do you think the boys feel about you, coming second in the grade?*

Nadiya: Juliet and I are friends and people would come up to us and say oh you’re clever, right! You’re the intelligent ones. And sometimes they make a joke and say oh no they’re so clever and if we go near them it might rub off on us. It is mainly the boys that do this.

CV: *Do you think there is a difference between the two Core Maths classes?*

Nadiya: We are like the higher grade class and because I don’t think the other maths class (pause) will be able to do the work that we do. It has to do with our abilities.

CV: *How do you think the boys in your Maths Literacy class view the Core Mathematics girls?*

Abigail: (pause) I for one think that some of them can be a little bit scared of the girls that do core maths. I know some of the guys feel (pause) a little bit intimidated especially when like Juliet and Nadiya are involved although I cannot really say because I have never seen any of the guys hanging out with Nadiya and Juliet. It is kinda hard to put some of the lit guys next to Nadiya and Juliet you know. They are just not on the same wave length at all.

Nadiya, Rehana and Juliet find it important to present a clever self and enjoy the power and status that this label affords them. The boys, as Nadiya suggests distance themselves from clever girls. This distancing is important, as Renold (2001a) suggests that boys' association with academic achievement can call their boyhood into question. Distancing themselves from academic success is also a way of proving a particular form of masculinity which also distances itself from 'clever girls'. What emerges is that girls' experiences of Mathematics are not uniform. Overall, whilst all three of these core girls disassociate with Mathematics, there is strategic use of it as these 'clever girls' construct distance from other boys and girls in carving out a prestigious position for themselves based on their clever status as Core Mathematicians.

CV: *How do you feel about the girls who do Maths Literacy?*

Rehana: Uhm (long pause) I don't really have any (pause) relationship with any of them.

Juliet: In general academics is very important to me (pause) even with all my friends, look at most of my girlfriends, most of them get high marks.

CV: *How do you think the boys in your class see you girls?*

Rehana: (pause) I think ah sometimes they felt a bit threatened ah at our achievements but in other ways we always like work together like Michael and I. Specifically him not anyone else.

What the above extracts highlight is the power invested in Core Mathematics and the identification of the core girls with Mathematics and hence with power and prestige. As highlighted in the Literature chapter Mathematics is constructed as 'hard', 'absolute', 'a proof of intelligence', 'certain', 'objective' and that owing to these discourses, Mathematics has the power to impress. In this process of identification, the clever girls distance themselves from the other girls and boys from both the Mathematical Literacy and Core Mathematics class. Rehana only has a relationship with one of the boys in her Core Mathematics class, Michael, and this relationship is only based on helping each other improve. Levels of hierarchy are thus created and used to establish status and power. These girls are creating a clever, intelligent, academic, ambitious, diligent work ethic in Mathematics and differentiating from Others in Mathematical Literacy, both boys and girls.

4.3.2. Hard working core girls

All three of these girls are hard working learners as the following extract shows. These girls are eager to work hard in Mathematics and are driven by the future promise of success to work harder. These three girls associate with Mathematics in ways that engender success for them, and this success is their springboard into desired careers.

Rehana: They (the boys) are very good but they're lazy so it doesn't help them if they are gonna be lazy cause they are not going to achieve at the end of the day. And the girls are a lot more ambitious and more want to work and work harder.

Rehana draws on the discourse which sees boys as naturally good in Mathematics but lazy, whereas girls like her have to work harder and harder in order to succeed. Referring back to Rehana's journal at the start of the section, she continually refers to working hard, trying harder and continually practicing the concepts so she can grab hold of them.

This brings into consideration the binary oppositions of:

Naturally able/Hard working
Mathematics and science/Language and art
Masculine/Feminine

This binary dichotomy works to inscribes Mathematics as masculine and produces power on the side of the 'masculine naturally able' and lack on the side of the 'hard working female'. Hard work, albeit a springboard to success, is often devalued by the Core Mathematics teacher who has repeatedly made reference to the fact that the boys are naturally more intelligent at Mathematics and that the girls succeed merely because of their sheer hard work. In the following extract taken from my field notes, the Core Mathematics teacher together with the other Mathematics teachers, myself included, were having a discussion in the staff room regarding the results of the mid –year mathematics examination:

You know who really continues to surprise me, Juliet, that girl continues to work so hard and applies herself diligently to everything I give her. It is by her sheer determination and hard work that she is knocking the socks off the boys who are for all intents and purposes are more intelligent – Mathematically that is. Despite her

having reached her Mathematical peak she is still able to out perform the boys in the class.

I did show this extract to Mr Berkowhizz and I asked for his permission to use this extract. The reason for this was an ethical consideration in light of the fact that I had previously stated to both Mathematics teachers that I would only use data collected during the observation of lessons. Mr Berkowhizz granted permission for me to use the above extract.

Juliet obtained 98% for her mid-year Mathematics examination and despite this incredible performance, her teacher has told her and her parents that she has reached her Mathematical limit and Juliet has herself internalized the fact that Mathematics is not really her area.

Juliet: Well, my dad wanted to see Mr Berkowhizz, so we spoke to him and he said what I have been trying to get through to my dad for ages and that is that maths is not really my area it's more English, I will do well in it but not very well and that (pause) is exactly how I feel.

In her journal, Juliet made reference to the fact that Mathematics was not her area four times. Indicating that she was far more orientated towards English and History. She stressed a qualitative self as opposed to a quantitative self on a number of occasions. However in recounting this data, it is important at this point to state that although Juliet does not see Mathematics as her area and she may not particularly like it, or see herself as being really good at it or wish to pursue it further after school, she would never even remotely entertain the idea of DROPPING (Juliet's own emphasis to show downward movement) to Mathematical Literacy even if she was failing. A similar sentiment towards changing to Mathematical Literacy was shared by Rehana and Nadiya. Both girls spoke about the option of DROPPING (Rehana and Nadiya's emphasis on the word dropping) to Mathematical Literacy as something neither they nor their parents would entertain even if they were failing Core Mathematics. If they landed in the position of failing Core Mathematics as Nadiya did in the first term, the solution to this was simple – you just had to work harder. The pressure that Core Mathematics induces amongst these girls is clear as

certainly they want to use the prestige and power associated with it to claim power for themselves, but also to ensure power in the future in terms of access to higher education and economic and social success.

These three girls may not necessarily like Core Mathematics, but contradictorily they like the power Core Mathematics gives them and they have each invested in that power. In addition to this, the value of Mathematics as powerful is supported by these girls' families and teachers. These girls have constructed their identities as 'brainy girls' around that power and they find real pleasure in the implications that this has for their future entry into tertiary education. Although brief reference was made to the way Rehana and Nadiya, the two Indian girls compared with Juliet, the White girl related in terms of their success or failure in Mathematics, in the next section, it is essential to continue with the analysis of the ways that these girls negotiate the power and prestige of Mathematics in terms of race and class.

4.3.3. The power and prestige of Mathematics in terms of race and class

Although all three girls showed similarities in terms of their relationships to Mathematics and how they negotiated and used the power of Mathematics to construct their relationships to other Core Mathematics and Mathematical Literacy girls and boys, a difference of opinion arose between the three girls when questioned about the prestige and status of Mathematics and Science.

CV: *Which of your other subjects is most like Core Mathematics?*

Nadiya: Physics

Rehana: Physics

Juliet: Physics

CV: *Do you think these two subjects share the same prestige and status?*

Nadiya: Definitely (pause) in the Indian community like in my uhm maths and science tuition class there are only Indians so I think if as an Indian child you like DROP TO (Nadiya's emphasis) maths literacy or if you don't take physics people, they will look down on you. They'll just ask you why you

didn't take physics or why aren't you doing maths. I know in my family maths and physics tend to take preference over other subjects or seem higher than other subjects.

Rehana: Yes, because with maths if you say you're doing maths it's like oh ok and if you say you are doing physics and oh they know in my family they generally ask are you doing maths and physics? They don't ask are you doing history or are you doing accounting or something. They ask are you doing maths and physics (pause) so if I say yes I am they're like Oh ok quite a brain sort of girl. Every Indian mom wants her son to be a doctor and her daughter to be a lawyer. But that is changing and we the Indians are looking at engineering and I.T and that sort of thing. For an aunt or uncle, if an Indian child wasn't taking maths and science, at the back of their mind cause they have been so conditioned I don't think that they would think very much of that child.

Juliet: I've never really bothered uhm I just ignore it because I think it is really silly to put subjects on a pedestal.

From the above extract it becomes obvious that the two Indian girls, Nadiya and Rehana and their families clearly see Mathematics and Science as high status and prestigious learning areas. The package of Mathematics and Science clearly has the power to impress the Indian middle and upper class community and both Rehana and Nadiya are acutely aware of this and enjoy the sense of power they feel in being labelled "a brain sort of girl". Both girls spoke at length of the importance that their families placed on education, and the importance of economic mobility particularly for middle to upper-middle class Indian girls. In using the term "class" in this section, I wish to move away from the understanding of class in terms of socio economic status, as all three girls come from middle to upper-middle class family. And move the understanding of class more to parental and family educational background and values.

CV: ***You brought up earlier that in the Indian community there is a strong focus on academics, do you think more so than the perhaps White community?***

Nadiya: I don't know mam I don't want to generalize but that is how I feel. Because like my mom (pause) she sacrifices a lot to send me to this school and uh that is my motivation to work hard cause I know she is giving up a lot and I think (pause) generally with Indians that they are very focussed. I mean my

mom always tells me that her father would never have allowed them to throw away their education.

CV: *Do your parents place value on having a good education?*

Rehana: Yes, my parents think education is important full stop! My mom is more laid back than my dad, he's more pounding on us like when it comes to exam times and you're sitting watching tv it's like ah I thought you were supposed to be studying. And we say ah dad it's like only ONE (Rehana's emphasis) programme (laughs) I can't study 24/7 so for him it's like when he comes home he likes to see us working. Although my dad ensures that we work hard, I feel the need to ah (pause) always do well not only for my parents but for ME (Rehana's emphasis) because it is like I realised that I've come so far and I need to go far if I wanna do the course I wanna do. I need to work hard and get that.

In the above extract Rehana spoke of how her father pushed his daughters academically and wanted them to succeed. However, despite the pressure from parents both Rehana and Nadiya spoke of their own ambition to succeed. They were working hard for themselves so that they could achieve all that they wanted, but they were also working in order not to disappoint their parents. Rehana was influenced by her father and she spoke of wanting to go into Financial Engineering because her father was a business man and she saw the exciting things that he does at work. So part of Rehana's personal desire to do well in Mathematics and school was connected to a need to gain her father's approval and to make him proud. Nadiya's desire to do well was also bound up with a need to make her mother proud of her as Nadiya knows exactly how much her mother has sacrificed to let her come to the school.

Whilst Indian middle and upper middle class families have high expectations regarding academic success, Rehana and Nadiya both show how they too have inserted themselves into and have accepted this positioning. The value of education and the upward economic and social mobility this brings with it in the elite Indian community that these two girls come from is evident in the extracts above. However, attention also needs to be drawn to the fact that all the Indian girls have "chosen" Mathematics and even in the face of "failure" will not change to Mathematical Literacy. This may point to a coercive or more strongly inscribed cultural and social norms and limits to freedom to choose for

Indian girls. Even the White girl Juliet spoke of observing the value that the elite Indian community placed on the learning of Mathematics and Science. However, at this point it is important to clarify that I am not generalising about the entire Indian community. These girls come from economically privileged backgrounds and attend an elite school and it is in this environment that academic success is valued and has meaning. There are some very poor Indian families in the Durban area, whose daughters attend under resourced schools and one may elicit very different answers and outlooks from these girls and their families in terms of the value of education and future careers.

In contrast to Rehana and Nadiya, Juliet did not see the relevance of placing any subject on a pedestal, yet her father was anxious to speak to the Mathematics teacher about Juliet's performance and believed that it was important that she not neglect her quantitative skills. Juliet's parents also place a high importance on the value of education, but she was quick to point out that this was because they wanted her to develop a holistic education and they were also not particularly interested in placing one subject on a pedestal above another. Whilst there are particular cultural values, prestige and power associated with academic success and the Indian girls in this study, the power of Mathematics is also clear within Juliet's family who wanted her to succeed as the extract below shows.

CV: *Are you an only child?*

Juliet: Yes

CV: *So your parents have lavished all their attention and resources onto you*

Juliet: Mmm, they have always told me that I can go anywhere I want to to attend a university and so on because they have enough money to send me where I want to go. The world is my oyster.

For both Rehana and Nadiya the importance of succeeding in Mathematics and Science is further highlighted by the fact that both girls attend extra tuition in these subjects for a collective total of four hours per week and have done so since the beginning of their Grade 10 year in 2006. The value that both Rehana and Nadiya and their families place on education is indeed part of the explanation for their success. However, it is important to

highlight that here in South Africa these two girls are not speaking on behalf of the entire Indian community. The reality is that these two girls come from very privileged families who have the financial resources to send them to an elite private school and to supplement their learning with additional weekly tuition that comes at a fairly expensive price. There are many Indian families in the greater Durban area who live in dire poverty or who eke out a meagre working class living and who cannot afford to give their children the same life chances that Rehana and Nadiya are getting.

4.3.4. Heterosexual femininity and the power of mathematics

This section focuses specifically on Rehana as she negotiates being 'clever' but also beautiful. Rehana is a petite, 16 year old Indian girl. She has flawless skin and thick long black hair. She has regular appointments at the beautician for facials, manicures and pedicures. Many of the boys in the school find her very attractive. During our interview, she had the following to say:

Rehana: My dad he always says he doesn't want ah not in a mean way he doesn't say in a mean way that he doesn't want ugly daughters so he says keep up your health, go to gym and do extra sport.

This section explores the experiences that Rehana spoke of in her extra tuition lessons as this shows how she negotiates the power of being beautiful and being good at Mathematics and how she uses these resources to give her an edge over other girls and boys. Nadiya did not speak much about attending tuition, she simply said that she needed to go as this helped her pass. In her personal journal, she wrote often of her tutor and that if it was not for him she would not be able to pass Mathematics. In contrast, Rehana spoke at length about her tuition but made it very clear to me that she did not go because she needed the extra help. She needed me to understand that she attended tuition just to 'be ahead'.

CV: *So you have been going to tuition from the beginning of Grade 10. Why? Did you have a problem?*

Rehana: No no problem, I just went for extra just to be ahead because I find that even with physics I go for Maths and physics with this guy and if I cover a

section first with him and cover it later on in school and I master the section at school and when I do a section first at school and then go to him I master the section there in his class. Plus he gives us tests and stuff so to do well in one of his tests and he always picks on certain people because he is grooming them for his top eight. So it is like perseverance because you wanna be one of those top eight. But there are other things as well he gives us references so he doesn't just indoctrinate that maths and physics is the be all and end all.

CV: *Does he make that top eight quite clear?*

Rehana: No, he doesn't but in an indirect way he always picks on those people who are and they generally get it right so in an indirect way we sort of know who those people are.

CV: *Are you in the top eight*

Rehana: Ah yes I am (laughs) and I am very proud of that achievement.

CV: *Do you think being a female has made a difference in your life in any way?*

Rehana: It makes a big difference (laughs) uhm being female lots of power; you have a lot more power in you even if no one else sees it. For me to be a woman you have like so much power if you are walking in a mall and ah (pause) if you're a girl and you're pretty people turn heads generally and if you are sitting in a classroom and you're a girl and you do something right people turn heads.

Rehana is a fiercely ambitious young Indian woman. She has her life clearly planned and knows exactly what she wants and how she will go about getting it. She is also a very beautiful young woman and has an air of dignity and refinement about her. She is the only one of the girls who labelled herself as being a 'Mathy' sort of person and was extremely proud of the fact that she was one of the top eight students in her extra tuition group. She wants to master her Mathematics and Science and is prepared to give up extra time during the week just to ensure that she 'gets ahead' in these subjects. Rehana enjoys the power and status that comes with being able to answer questions correctly in class and turn people's heads. She also enjoys the power of being beautiful and being able to turn people's head while walking in a mall. Rehana is negotiating being a beautiful heterosexual female with her Mathematical success and both are powerful resources that she can draw on to give her the edge over other girls.

In stark contrast to Rehana's statements about the power attached to being both bright and beautiful, Juliet the white girl, although very intelligent has no idea what career she wishes to pursue, although she is very quick to explain that her skills are more qualitative than quantitative. She takes extreme pleasure in the fact that she achieves good results and continually comes top of the grade. She speaks with pride at having being awarded an academic scholarship at the school which runs from Grade 8 to Grade 12. However, when I asked Juliet if she thought being a female had made a difference in her life in any way, the question perplexed her and she had trouble answering it. She reverted back to the academic points she had made and unlike Rehana, did not make reference to having feelings of power about being a female. For Juliet, her Mathematical prowess is the most powerful resource she has and she does not value the power of heterosexual femininity.

CV: *One of the girls said that you do Maths for fun and that you are excellent at it. How do you respond to that?*

Juliet: Well when I was younger I used to do maths puzzles for fun but now I am more qualitative than quantitative and find I prefer crosswords that that. How would I respond to someone who said I was excellent at maths (pause) I would say Ooh I LIKE that person.

CV: *That morning before we met, it was a public holiday and you said that you had spent the entire morning playing on the computer. Do you like your own company?*

Juliet: Mmm ja of course I talk to my friends and don't completely shut them off but I think personal space is also very important. I like my own area and I don't like people disturbing me when I am in my own little happy zone... ..once in a while I think it is ok as long as it is only in very small doses. I can have a really good time with one of them for an afternoon when I let my silly side go, but on an everyday basis I think that I would strangle them. Makeup, hair, clothes and boys are not at the top of my priority list and I can do without thank you. My dad has said to one of my friends that he will give us R2000 if she takes me shopping for clothes and stuff. No, no interest.

Another dimension of the analysis across race was the girls' references to their fathers. Both Rehana and Juliet refer to their fathers alluding to aspects of sexuality and the link to intellect. Both fathers construction of their daughters seek to connect "brains and beauty" as signified by feminine bodies/health and clothes. For these fathers being "bright"

by itself, it would appear, is not enough (Renold, 2001b).

Competition for Rehana, Nadiya and Juliet are vitally important and these girls enjoy the Mathematical power that they have. All three girls said it was important to be viewed by others as being good in Mathematics. Being seen to be good at Mathematics is an important tenet of their identities and a power resource which structures their relationship with others and sets them apart from others. For Rehana however, unlike Nadiya and Juliet, heterosexual femininity is valued and she couples this power with the power she gains from Mathematics to give her a competitive edge over both Juliet and Nadiya. However, on the surface none of the three girls will admit to being in competition with each other.

The relationship that each of these core girls construct with Mathematics is fraught with contradictions and emotions. Although Rehana, Nadiya and Juliet have admitted to not always liking Mathematics, all three of them have invested in the power of Mathematics to show their own power and to position themselves as being clever girls. All three girls show how they use being clever in Mathematics to construct other boys and girls differently. For Nadiya, Rehana and Juliet it is important to be seen as a 'Mathy person' in terms of the power associated with Mathematics. These three girls negotiate Core Mathematics and its concomitant power in relation to Mathematical Literacy and for them dropping out of Core Mathematics is not an option. The reason for this is that the power of Core Mathematics is not only the power that they see in their own identities as girls but also a valuable resource to ensure their future entry into higher education and status careers.

The above extracts and analysis confirms the literature that identity is not fixed, absolute or pre-given, but according to Hall (1990), is a product of historically specific practices of social regulation which is in continual construction and reconstruction. The identities of the girls in this study shift and fragment across "discourses, practices and positions" (Hall, 1990, p. 4) and are constantly in the process of change and transformation, always in process and never entirely complete. Castells (1997) argues that the girls in this

study are located in myriad power relations at the micro level of society, and in a complex web of discourses that offers them many ways of seeing and being. They have the agency to draw on these consciously and unconsciously, and in differing ways take up or reject the positions offered to them. Each one of the six girls in this study distinguishes herself from others, and in relation with others.

I now turn the focus of this analysis chapter onto the three Mathematical Literacy girls and explore the relationship that they have with Mathematics.

4.4. 'NOT THE BRIGHTEST LITTLE SPARKIES IN THE PACK' – LIT GIRLS

The above title is taken from an interview with Madison, as she referred to the way she thought the Mathematical Literacy teacher viewed the learners in his class. I use the expression 'lit girls' in this section as this is how the girls referred to each other.

This section deals specifically with the three mathematical literacy girls, Chrystal, Abigail and Madison. All three girls are White girls who come from upper –middle class families. A point of interest here is that, there are five Indian girls out of the fourteen girls in Grade 11, and not one of these Indian girls takes mathematical literacy. Madison is an only child; Chrystal has a brother and sister who are fifteen years older than her, so she is the only child left at home. Abigail is the oldest daughter in her family. All three girls' families emphasise the importance of education, both Abigail's parents and Chrystal's father have tertiary degrees. Madison comes from a divorced family and her mother was medically boarded a number of years ago. Her father lives in Germany and specializes in computers and Information Technology. Madison started 2006 taking Core Mathematics but had to consider a move to Mathematical Literacy as she was failing and could not cope with the work. All three of these girls hold positions of leadership as College prefects.

Before I embark on my analysis of the relationship that these three girls have with the learning area of Mathematical Literacy or how it becomes part of their identity work, it is important to show how the Mathematical Literacy as a subject is being constructed by

both teachers and learners themselves. Despite the government categorically stating that the learning areas of Mathematics and Mathematical Literacy carry the same status and educational value as subjects, this has unfortunately not transpired in the schools. The following extract is taken from an interview with one of the Mathematical Literacy girls who spoke about the snail's pace at which they were taught.

CV: *I noticed that the pace of the lesson is slightly slower than in the Core Maths class.*

Madison: Slightly (laughs loudly) come on mam. I think it's because Mr Schekter believes in one step at a time (pause) because I think he has got the mindset also that maths literacy they are not the brightest little sparkies in the pack. Ok so it is not nice that he thinks we are slow.

The following extract is taken from my field notes:

February 2007: I have just had the first meeting with all the Grade 11 girls to tell them about my intended research project and to give any of them the opportunity of excusing themselves from participating. It was very interesting that after I had told them that I was interested in exploring the way that girls in Grade 11 in this school constructed their relationship to Mathematics and Mathematics Literacy, that both Abigail and another girl put their hands up to ask a question. What Abigail asked was: *Mrs Vermeulen will you think any less of us because we do Maths Lit?* The other girl had the same question.

The overall opinion that teachers and learners have is that Mathematical Literacy learners are slow and the subject content is a watered down version of the real thing, Mathematics. It has become labelled, certain in this research site as 'easy' or 'soft' Mathematics. In fact many of the Core Mathematics learners question whether the Mathematical Literacy learners are learning Mathematics at all.

CV: *What do you think the Core Mathematics learners think of Mathematical Literacy?*

Abigail: Ah, I think that they think maths literacy is a joke because when we got our books last year and they were like 'what are you guys like doing home economics or are you actually doing maths' that was the one thing they went over and over about because as it was the first thing that was in the book – cooking and it was dealing with volume and measurement as stuff like that

and they thought it was just funny. They couldn't believe that this was mathematics and they were like ja you guys are doing home ec not maths. And it was a big thing.

From observing lessons and listening to what the Mathematical Literacy girls, the Core Mathematics girls and boys in general have had to say, it appears that Mathematical literacy has developed the stigma of being an easy option and that it has developed a lesser status than even standard grade Mathematics had. In a short space of one and a half years the learning area of mathematical literacy has been labelled as 'soft', 'easy' Mathematics.

As with my analysis of the Core Mathematics girls it is impossible to simply assess the relationship that these three 'lit girls' have with Mathematics based on whether or not they intend to pursue a career in the field of Mathematics. Therefore, it was essential to look at the journals I asked each girl to keep in order to further illuminate the way that each girl related to Mathematics. The following extracts were taken from the journals that Chrystal, Abigail and Madison kept:

Chrystal made three entries into her journal and all were made during her maths lesson of the day, she writes that today is not a good day maths bores me. Maths went alright; it went by quickly which is always good. Maths was such a bore, I spoke to a friend a lot during the lesson, was not interested in maths.

Abigail's journal is full of colours and lots of little drawings. She begins her journal with the following comment in big bold purple letters, **OK: NOW I CAN'T CONCENTRATE** – concentrate, concentrate, concentrate, concentrate, concentrate, concentrate, concentrate, concentrate, concentrate, concentrate. I'm totally confused don't understand. He is talking and all I hear is mathematical jargon which makes not sense to me at all. That is the last reference to maths that Abigail makes the rest of her entries are related to another girl in the class whose hair is irritating Abigail and a birthday message to herself and reference to the surfboard she received as a present. One of the other girls in the mathematical literacy class has written an entry into Abigail's journal and it says: Dam Abigail, I have not understood anything since I walked into the classroom from the beginning of the year. How do we pass?

Madison begins her journal with the following: Matthew (a core mathematics learner) told me today that maths lit is sooo easy because in Life Science we were doing easy calculations and he called it maths lit work. Then I was working on an easy calculation that could be done without using a calculator, but I was using a calculator and he mocked me about being in maths lit. In her next entry, Madison

writes: I am so bored, I really wish Belinda (not the girl's real name) would tie her hair up, she looks like a boy and it does not make her look any prettier. This is the same girl Abigail referred to. Madison concludes her journal by writing: So over maths but loving my new pen though – LUMO PINK!

From the above journal entries it becomes quite obvious that these three girls do not have a very positive relationship with Mathematical literacy. All three girls write about how bored they are or how they battle to concentrate during lessons. What struck me whilst reading these entries was the limited references that these three girls made to Mathematics or in stark contrast to the 'core girls' none of the 'lit girls' made any mention of their results or the emotions related to doing well or failing. Their entries centred more on the social events of birthdays, presents and one girl whose hair bothered both Chrystal and Madison. During the three hour long observations that I conducted in the Mathematical Literacy class the same point struck me, and that was how the learners did very little Mathematics work although this was set for them by the teacher. They preferred to talk and socialise during the entire lesson. Of further interest was when I looked at the class schedules, which is a listing of every learner's results (see appendix 1) at the end of each term I noticed that none of the learners who took Mathematical Literacy, failed the subject. Further to this end Chrystal, Abigail and Madison had the following to say:

CV: *What have you enjoyed most about your Maths lessons this year?*

Chrystal: (laughs) I am not a fan of Maths, but I like the fact that we can talk to our friends during lessons and we can work together.

Abigail: Well, I've enjoyed the communication with my peers. I prefer working in groups as I can ask for help. If I have to work by myself I get highly frustrated especially if I do not understand the subject (pause) like maths.

Madison: The fact that we can talk (laughs) Maths lit is A LOT (Madison's emphasis) more user friendly than Core Maths. There is a more informal atmosphere and it is not oppressive like core maths. Uhm what I have enjoyed the most uhm (pause) my friends and that they're there cause most of us are like in maths lit.

In light of my own observations and Chrystal, Abigail and Madison's testimonies it has become clear that Mathematical Literacy has become seen as the easy route to take. This has in turn increased the status of Core Mathematics as a hard, proof of intelligence, rational and masculine subject. It would appear that Core Mathematics today carries a higher status and more prestige than higher grade Mathematics did and this has depreciated Mathematical Literacy to a level lower than standard grade Mathematics.

CV: *Do you think that there is a stigma attached to Maths Literacy?*

Nadiya: They are very different like they're very different to the people that do Maths. Sometimes a Maths Literacy student will bring a test to us that they have done and ask like 'how do you do this?' and it will be so easy and you know we will just make a joke about it.

Rehana: Ah (pause) yes. Maths Literacy sounds more retarded in a way. Standard grade Maths was ok (pause) uhm still acceptable, but Maths Literacy just makes it sound a lot worse.

Juliet: Uhm I need to think of someone (long pause) I'm trying to think of an example. Oh right Ok! They're (pause) yes it does have a stigma attached to it. A stigma that some of them are a bit stupid. Probably because it is even a new name "literacy" (pause) it sounds like oh you are too stupid to do maths.

Madison: Uhm (pause) I don't really know too much about the stigma about being on standard grade but to fail standard grade it was like "oh my word" it is kind of the same because if you fail maths literacy you're like (exaggerated intake of breath) "wow how dumb are you?"

Chrystal, Abigail and Madison, the three 'lit girls' have had to negotiate not only the learning area of Mathematical Literacy, but also the depreciating opinions of teachers and Core Mathematics learners. In Nadiya's above statement she speaks about making a joke out of the Mathematical Literacy learners and acknowledges that the Core Mathematics learners mock others who do badly at Maths. These opinions of them as "not being the brightest in the bunch, retarded, dumb and stupid" clearly have had an impact on the Mathematical Literacy girls as Madison begins her journal with an account of being made fun of because she does Mathematical Literacy. Throughout my interviews with

Chrystal, Abigail and Madison they spoke of the jokes and how this made them feel irritated and angry. They did not think that these jokes were at all funny. This constructs them as being the 'Other' in relation to Core Mathematics girls, a view also shared by teachers. These Mathematical Literacy girls are negotiating and constructing their identities in terms of subordination to the power of the Core Mathematics girls.

CV: *So would you classify yourself as being good or bad at Mathematics?*

Chrystal: For Maths Lit I think I am good for hard core I was very bad. And there is a big difference between the two (pause) core and lit.

Abigail: When I was younger, in primary school I was good. Now I get frustrated and I push the subject aside, so I think I am bad at both Core Maths and Maths Literacy.

Madison: Well I think I am doing ok for myself in Maths Lit.

CV: *In Core Mathematics, were you good or bad?*

Madison: I sucked!

All three of these 'lit girls' have done well in terms of their academic results in the Mathematical Literacy. Chrystal, Abigail and Madison all spoke about enjoying the content of Mathematical Literacy because it taught them things that were relevant to their everyday lives. This contradicts what all three girls wrote in their journals how they were bored in Mathematical Literacy classes and how they struggled to concentrate. All three girls were quick to point out to me during their interviews that there was a vast difference in terms of Core Mathematics and Mathematical Literacy and as the above extracts show, all three girls spoke about being bad in Core Mathematics. They all said that it was easy to succeed in Mathematical Literacy as there was less pressure and the work was easier to understand.

Chrystal, Abigail and Madison labelled themselves as failures in terms of Core Mathematics and had constructed identities that excluded the power attached to being a 'core girl'. Admitting that they were bad at Core Mathematics automatically positioned them as lacking power and being beneath the girls who do Core Mathematics. Even though Chrystal, Abigail and Madison were doing well in Mathematical Literacy their success in this learning area was seen by teachers and other boys and girls as not excelling in the real thing. The following extract shows how Madison has had to negotiate not only the subordinate position of being a Mathematical Literacy learner at school, but she speaks in detail of how dropping out of Core Mathematics has positioned her in a subordinate and powerless position in terms of her family as well.

CV: *How did your dad react when you told him that you moved from core Mathematics to Mathematical Literacy?*

Madison: He was not IMPRESSED (Madison's emphasis) he questioned me saying why are you doing it Madison are you sure about it? What's wrong? And then he was like ok.

CV: *Did you feel like you had disappointed him in any way?*

Madison: I felt like I had disappointed my whole family. But (whispers) my grandparents on my dad's side. My grandfather is an ex-accountant, my cousin she's doing add maths as well, absolute genius. My grandmother was very clever and my dad, well my father is absolutely brilliant! My uncles all brilliant. All my family on my dad's side brainy Mathematicians boffins. I feel like the black sheep of the family because I can't do Maths and I did not take Physics.

CV: *What does your dad say when you tell him how well you are doing in maths lit?*

Madison: Every time I tell him my Maths Literacy mark he's not really interested. Now if I got 80% for Core Maths, he would be over the moon and my grandparents would be too. I could compete with my cousin Melanie, who incidentally is in the same Grade as me but at an all girls school.

Madison talks here about the value that her dad's family (who clearly excel at mathematics) place on taking Physical Science and Core Mathematics. Rehana and Nadiya's (the two Indian girls) families have the similar ideas and expectations of their daughters. However, unlike Nadiya who also failed Core Mathematics and would not even

consider changing, Madison decided not to continue taking Core Mathematics and decided to change to Mathematical Literacy, the easier option. She had excluded Core Mathematics from her identity, although she knew that this would disappoint her entire family and close numerous future career options. By changing to Mathematical Literacy, Madison gave up the power invested in Core Mathematics and was carving out a subordinate position for herself in relation to core girls, her brilliant cousin and her father's family. From observing and listening to the way Madison spoke at this point in our interview, it was clear that she battled with the fact that she had disappointed her family and even more so now that she could no longer compete with her brilliant Core Mathematics cousin who was the same age as her but attended a more affluent independent all girls school.

Teachers, learners and parents in this school environment have placed Core Mathematics on one extreme end of a continuum and imbued it with power and placed Mathematics Literacy on the other extreme end of the continuum and labelled it as soft maths and 'a joke' and therefore it has been rendered powerless. This positioning has produced unequal gender relations in terms of the ways that Core Mathematics girls relate to Core Mathematics boys, Mathematical Literacy girls and boys. Similarly this positioning has led to unequal gender relations in terms of the way that Mathematical Literacy girls relate to the girls and boys who do core Mathematics and the boys who do Mathematical Literacy.

Chrystal, Abigail and Madison spoke about how Nadiya, Rehana and Juliet continued to do extremely well in Mathematics and they were extremely impressed with the way that these three girls continually managed to secure the top positions in the grade.

Chrystal: (laughing) Look at Juliet she is very very good at Mathematics.

Abigail: The guys who are good at Maths aren't as good as the girls. I can see most of the girls like Nadiya and Juliet making a career out of it. Some of the guys have to do it so they just do it.

Madison: I would tell them to look at the core girls and tell me that they aren't clever. Look who is getting the higher marks in the class. Who is getting that? I bet you Nadiya, Rehana, Juliet?

For the 'lit girls' being good at Mathematics like Rehana, Nadiya and Juliet are clearly has the power to impress. This brings into the analysis the fusing together of "the intellectual" with "the Mathematical" and how one acts as a place holder for the other. Chrystal, Abigail and Madison see Rehana, Juliet and Nadiya's Mathematical ability as an indication of their overall intellectual ability and are clearly impressed by it. This elevates and empowers the 'core girls' and subordinates and disempowers the 'lit girls', further illuminating the unequal gender relations in terms of the ways that Chrystal, Abigail and Madison relate to Rehana, Nadiya and Juliet and vice versa.

The identities of these girls, both core and literacy, are being produced in relation to two dimensions of Mathematics. The core girls who see themselves and are seen by others as good in Mathematics are locking into the discursive construction of Mathematics as masculine and powerful and are using that power to shape the way they view themselves and others. These clever girls negotiate Core Mathematics in terms of avoiding all that is related to Mathematical Literacy. By avoiding all that is Mathematical Literacy, the subject, the boys and some of the girls, and embracing all that is Core Mathematics, they employ the power associated with Mathematics to present themselves as powerful and brainy. The girls who have dropped to the lower level of Mathematical Literacy are producing identities that are subordinate to those of the clever core girls. Their avoidance of all that is Core Mathematical and negotiating the 'soft', 'easy' option of Mathematical Literacy shapes them as the powerless 'Other' of the powerful Core Mathematics girls.

4.5. GIRLS NEGOTIATING THEIR SEXUAL SELVES IN RELATION TO CORE MATHEMATICS AND MATHEMATICAL LITERACY

In this section, I focus mainly on the core girls and illustrate how, for them, gender and sexuality are key features in their disposition towards Mathematics. The reason for this is that, for the core girls in this study, Mathematical ability and its future promise of

economic and social capital is an important marker of sexual desirability. To highlight the contrast, I briefly draw on the data from the Mathematical Literacy girls showing how, for them, Mathematical ability is not central to sexual desirability. Further to the above, this section looks at how the Core Mathematics girls Nadiya, Rehana and Juliet who are described as being good in Mathematics, lock into the discursive construction of Mathematics as masculine and powerful and this shapes how they view the boys who either do Core Mathematics or Mathematical Literacy. In conclusion of this section, I present Juliet's story relating to her relationship with Romeo and Mathematics. In recounting this story, I show how, for her, sexuality and Mathematics are inextricably interwoven.

CV: *Would you go out with or date any of the boys in the Mathematical Literacy class?*

Nadiya: (laughing) honestly mam (there is an edge of humour in Nadiya's voice) The boys that are actually (pause) sitting in the Maths lit class. Most of them (pause) are really (long pause) immature (pause) don't have two brain cells to put together (Nadiya giggles) So no, I would not go out with a boy who did Maths Lit at all.

Rehana: (quickly) No. I consider them dumb (laughs) it's like ah you always want a guy that's a brain and you know and cannot do Maths cause if you look at the many people that are in Maths Lit they are very immature and they take it like they are not going to do anything with their lives nobody wants that.

Juliet: Uhm (laughs) ok, (pause) NO (Juliet's emphasis) no [she makes a sarcastic gesture] my standards are far too high that's the problem (laughs) I want someone who's intelligent and I can hold an intelligent conversation with. I'm not interested in somebody who's got no brains

What the above extract highlights is that Nadiya, Rehana and Juliet associate with Mathematics in ways that engender success and for these girls success in Mathematics is also seen to be heterosexually desirable. For these three 'core girls', boys who are not clever in Mathematics hold no sexual appeal and thus for them being clever in Mathematics is a key marker of desirability and sexuality. This is unlike much of the literature which points to girls' preference for "macho lads" (Mac an Ghail, 1994) because here we have an

example of clever girls associating positively with the so called ‘nerdy boys’. Nadiya and Juliet elaborate on the association that these clever girls have with boys who show Mathematical prowess and intellect and in doing so distance themselves from boys who display a macho masculinity or a sporty masculinity when they state:

Nadiya: Because (pause) firstly there is more to life than looks and secondly uhm I like to talk uhm I mean I can’t sit with a person and not talk to them. I am just that type of person and if I can have a good conversation with him that’s even better I mean uhm I don’t really want to spend half an hour talking about rugby or you know how hot this girl looked. If you can see that he is intellectual and you can have a good conversation with him and he’s respectful.

Juliet: Well, I need someone who I can have an intellectual conversation. I don’t or won’t have to spend my days talking about rugby and showers and farting and that kind of thing (sorry) I’m sorry but that is just what some of our boys are like.

For Nadiya, Rehana and Juliet Mathematical ability is more important than looks because for these three ‘core girls’ Mathematics is money, status and power and that added together equals sex appeal. Rehana specifically states that she is not interested in any boy who is not going to succeed and do something with his life. For these girls the equation is simple $\text{Mathematical capital} + \text{economic capital} = \text{sexual and social capital}$ and they are not going to settle for anything less. Juliet clearly points this out when she states, “My standards are just too high and that is the problem”. Nadiya, Rehana and Juliet negotiate their sexual identities around Mathematics. In stark contrast Chrystal, Abigail and Madison, the ‘lit girls’ had the following to say:

CV: *Would you go out with or date any of the boys who do Core Mathematics?*

Chrystal: (pause) I would go out with any guy it doesn’t really matter what they do (laughs)

Abigail: It wouldn’t really bug me whether he did Core Maths or Maths Literacy or didn’t do Maths at all (laughs) it is just about the person I guess.

Madison: Yes I would, I think that (giggles) ok, that they would have to play rugby or at least a sport but (pause) if they have the brains why not I mean if they can do it it doesn't make them a nerd.

For these three girls, Mathematical ability is not important and both Chrystal and Abigail have stated that it does not matter whether the boy does Mathematics or not. For them Mathematical ability does not equate to sexual appeal. Madison is drawn to the sporty masculinity as she states that for her it is important that the boy plays rugby or a sport. This represents a big difference between the sexual identities of the two groups of girls. The Core Mathematics girls state that they have higher standards in terms of what they are looking for in a prospective boyfriend. For them a boy who is not clever in Mathematics is not desirable and holds very little if any sexual appeal.

The differences that Nadiya, Rehana and Juliet see between the boys that do Core Mathematics and those boys who do Mathematical Literacy are important as different masculinities are being carved out and distinguished. Nadiya makes the following observations relating to the difference between core mathematics boys and mathematical literacy boys,

Nadiya: I don't know, they are very different like they're very different to the people who do Maths. Ok mam like over here is someone like Michael (a core Mathematics learner; Nadiya raises her hand high above her head indicating a position) to someone like Devin (a Mathematical Literacy learner; Nadiya lowers her hand almost to the floor). You can see the kind of difference between them. I am not judging them, it's their life, but you can see the differences as in the way they treat the girls, the language they use, how they speak in public (pause) just their like general attitude and (pause) how they carry themselves it's quite different.

In pursuing this difference further, Nadiya and I had a follow-up interview which I did not audiotape but I took notes. She made reference to that fact that the boys who did Core Mathematics were generally well groomed and neat in their appearance. She said that they took pride in wearing their uniforms neatly and ensuring that their hair was neatly cut and their shirts tucked in. She also said that the boys who did Core Mathematics did not

wear their pants around their hips and show off their underwear. Although she quickly pointed out that not all Mathematical Literacy boys were untidy and unkempt. She continued that the boys who were learning Core Mathematics generally had a positive attitude towards school and very seldom got into trouble with teachers or broke the school rules, whereas more of the boys who did Mathematical Literacy were the ones who often broke the school rules or were in trouble with the Head of Department of discipline. She quickly pointed out that there were some boys who did Mathematical Literacy that did not always break the rules and get into trouble. When I questioned Nadiya about the way that Core Mathematics boys treated girls as opposed to Mathematical Literacy boys her response was simple. Core Mathematics boys treat the girls like ladies. They try not to swear around the girls or talk about who they were going to date next and were generally respectful around the girls. However, she says that the boys from the Mathematical Literacy class often swore around the girls and their conversations about girls usually had an unsavoury sexual undertone that made the girls feel uncomfortable. She also mentioned that the boys who did Core Mathematics were articulate public speakers who had more than likely completed the Toastmaster's programme whereas the Mathematical Literacy boys did not have a good vocabulary and often 'grunted' out responses. They "embarrassed themselves when they open their mouths" (quoted directly from Nadiya). Although she did end off by saying that she had been very harsh and not all Mathematical Literacy boys were uncouth savages and not all Core Mathematics boys were real gentlemen.

Even though Nadiya constructs the Core Mathematics boys as being gentlemen who have a positive attitude towards school and value academic success, these boys are not labelled by Abigail and Madison as nerds as the following extract shows,

Abigail: Just like the Core Maths people make a joke about Maths Lit, we could also make a joke about them as being nerdy people, but I don't know argh like Matthew is not nerdy, he's a normal person and he does Core Maths.

Madison: If they have brains and can do Core Mathematics it doesn't make them a nerd.

However, I am inclined to say that the ethos of Glenville College may have something to do with these Core Mathematics boys not being labelled as nerds. The religious ethos and family spirit of the school may play a big part in the acceptance of this academic masculinity. I think in bigger schools where sporty masculinities and macho masculinities are cultivated and extolled, boys who succeed academically would be more marginalized by other boys and girls. Despite the nature of the school, the boys are still actively involved in carving out masculinities that are important in this particular school setting.

Although this study does not focus on the boys, what emerges from the testimonies of both the Core Mathematics and Mathematical Literacy girls is that just as the girls are carving out positions of prestige and power in terms of their status as core Mathematicians, so too are the boys. The boys are constructing important masculinities around their success in Core Mathematics and in relation to the devalued status of Mathematical Literacy. The boys learning Core Mathematics continually mock and tease the learners doing Mathematical Literacy. In the following extract, Chrystal speaks about one of the boys who took Core Mathematics but had to change to Mathematical Literacy as he could not cope with the standard of work required.

CV: ***What have you heard the Core Mathematics boys saying about Mathematical Literacy?***

Chrystal: Well they make jokes, which they think are the funniest things on earth. I think it is very funny because Andrew used to do Core Maths and he would like really knock us about being Maths Literacy people and now now he's actually come down to Mathematical Literacy and that is very funny.

What I found very interesting was the following statement Abigail made about why the Core Mathematics boys mock, tease and make a joke out of Mathematical Literacy.

Abigail: The only reason why the boys mock and tease us about being Maths Lit people is that they are terrified that they are going to land up down here with us. And their jokes like would've backfired on them.

In the final section of this analysis chapter, I wish to focus specifically on Juliet as she attempts to downplay her sexuality yet contradicts this by engaging in a conversation with me over Romeo (the name Juliet gave him) on whom she has had a crush since Grade 4.

4.5.1. Romeo and Juliet

Juliet is a proverbial 'plain Jane' she does not worry about keeping up with fashion and make-up. Her femininity is based on playing down her sexuality. For her there are far more important things than shopping and gossiping and these are reading and educating herself.

Juliet: I have no aspirations to go home and put make-up on and straighten my hair. No (in an exaggerated exhale of breath and in a whisper) thank you. At this moment it is a waste of my time.

Juliet is the only one of the three Core Mathematics girls who has a very congenial relationship with the Core Mathematics teacher, Mr Berkowhizz. From the observations in the Core Mathematics class, it becomes clear that Juliet is very comfortable in the class and very vocal. She banter often with the teacher and she is the only one in the class that he has an affectionate nickname for. He calls the other girls in the class by their first names and the boys he address by their surnames. During our interview, Juliet often referred to Mr Berkowhizz as a big teddy bear and that she thought he was a fantastic teacher. In contrast to this, Rehana and Nadiya were very quiet in class, only entering into the conversation when it was mathematically related. Both Nadiya and Rehana commented that Mr Berkowhizz had a very comfortable relationship with Juliet but not really with them, but they were not overly concerned about this.

Juliet does not bother about what other learners think or say about her and she often states that people irritate her and she cannot tolerate their incompetence and lack of brains. Juliet does not suffer fools lightly. It is important to give an account of the above details as it is important to see that Juliet's answers emanate from the type of girl she is. Juliet would

probably be labelled as a typically studious nerdy girl and she would not bat an eyelid at this label, in fact she would be proud of this label.

CV: *Do you think that it is more acceptable for boys who do Core Mathematics to date girls who do Mathematical Literacy than for girls who do Core Mathematics to date boys who do Mathematical Literacy?*

Juliet: No I tell you uhm dating is not my area of expertise so I think it is quite silly to follow social trends and so on and the stigmas of I must go out with somebody who is above or below me whatever, so I wouldn't know about that.

Juliet tries very hard to deny her sexuality, and repeatedly made reference to the fact that she was not 'into dating' or that it 'wasn't really her thing'. For Juliet, having a boyfriend or presenting a beautiful, well manicured, well groomed self does not top her list of priorities. Juliet is by no means an unkempt girl; she is neat and tidy and that is sufficient for her.

Although Juliet tries very hard to deny her sexuality, she presented a very different image as she and I walked back to the school car park after our 'official' interview. We were having a discussion about marrying someone who is the complete opposite of oneself. Juliet then began to tell me about a boy that she thought was 'fantastic' and that she had been in love with since Grade 4. Romeo is a very intelligent boy, lazy according to her, who does debating, public speaking but also plays sport. According to Juliet he is the bench mark for her and she compares every other boy to him. She repeatedly told me that she has very high standards, but Romeo certainly met those standards and he was the only one she had met that did. Although she is in love with him, she has never actually told him so. The two of them are friends, and she told me that she was now tired of waiting and was going to approach Romeo and declare her undying love for him. The way she intended to approach him and tell him reminded me of exactly the same way Juliet would approach solving a Mathematical problem. It was very factual, straight-forward and almost clinical, nothing flowery and romantic as I would have expected from a 16 year old girl.

Throughout her account of her emotionally tormenting (Juliet's own words) lack of a relationship with Romeo, she could not stand still and she displayed some 'girly' emotions for the first time. She was excitable, couldn't stand still, giggled frequently and blushed often as she told me that her attraction to Romeo ebbed and flowed, but it was particularly unbearable at the present moment. Her body language betrayed the words that she attempted to make as rational as possible. The conversation ended with her telling me that she was going to confront Romeo the next day and let him know. Although this data was unofficially collected, I did ask Juliet to read my notes on this conversation to ensure that they were accurate and then I asked for her consent to use this data. She gave me permission to use the data collected from our conversation.

This above incident is in stark contrast to Juliet attempting to deny her sexuality and claiming that 'dating was not really her thing'. Recounting the above incident is important as approximately two weeks later Juliet came to see me and tell me that she had just received her June Mathematics examination back and that she had achieved 98%. What was particularly interesting was that while Juliet was telling me about her excellent result, she displayed the exact excitability, inability to stand still, giggling and blushing that she did when she was telling me about her attraction to Romeo. Two completely different events, one romantic emotional and typically feminine and the other Mathematical, rational and masculine were able to elicit the identical response from Juliet. For her, her sexuality and Mathematics are inextricably interwoven.

Drawing from Renold (2006; Renold & Allan, 2006) Juliet not only constructed her femininity against 'girly femininities', Juliet did not present herself as a 'tomboy' either as she wasn't interested in sports, socializing with boys at break times or engaging in other traditionally 'masculine' activities. Juliet's ambivalent femininity as strong-minded, independent, anti-girly, anti-boy, clever, and liking her own space pushed the normative boundaries of 'doing girl' – and doing heterosexual white South African girl.

4.6 CONCLUSION

This analysis chapter has centred on the Mathematical stories of six Grade 11 girls from an independent Catholic school. The chapter began with looking at the overriding theme of mathematics as Masculine amongst all six girls. I then disaggregated the data and displayed how each of the two groups of girls negotiated, used and strategised around Mathematics. This analysis chapter further illuminated that the girls in this study associate with two kinds of Mathematics: that of Core Mathematics and Mathematical Literacy and further to this, they relate to Mathematics in terms of the hierarchies and power vested in each.

In fact it has come to light that despite the resource-rich contexts from which these girls emerge in terms of education and family, Mathematics is nonetheless constructed as a masculine domain and this makes it difficult for them to form a positive association with it. What emerged is that while it is true that doing Mathematics is doing gender, it is also not true that because of its construction as masculine that the six girls in this study simply disassociate from it and reject it. There is evidence showing various levels of enjoyment and a need for success in it.

Close attention was paid to the ways that girls' identity formations give meaning to sexuality in relation to Mathematics. For the girls in this study, who occupy different ability groups, doing Mathematics is tied up with doing gender and performing certain types of femininities solidified through action in the school in collaboration or tension with others. I showed how sexuality is embedded within the doing of gender and how in doing Mathematics these six girls are not only doing gender but sexuality as well.

What this analysis chapter has shown is that when each of these girls relates to Mathematics, they do not relate to Core Mathematics or Mathematical Literacy alone, but their relationship to Mathematics is embedded within social processes including sexuality, gender, race, class and age and these are actively acted upon. I now present the concluding chapter of this thesis.

CHAPTER 5 CONCLUSION OF THE STUDY

5.1. OVERVIEW OF THE STUDY

This study focuses specifically on the ways in which independent schoolgirls differentially positioned in Core Mathematics and Mathematical Literacy construct their relationship to Mathematics. In this chapter, I draw together the ideas raised in the exploration of the words and actions of this study's participants. First, drawing on qualitative, poststructural feminist research approaches, I summarise my answers to the following research question: **How do Grade 11 girls in a Catholic coeducational independent school construct their relationship to the learning areas of Mathematics and Mathematical Literacy?** In answering this question, the following two sub-questions, which are embedded in the above, will be answered:

- How do they see themselves in relation to Core Mathematics Mathematical Literacy?
- What are their gendered experiences of Core Mathematics and Mathematical Literacy?

The question of how the girls “see themselves” is an identity questions and draws attention to the various ways each girl positions herself relative to Mathematics and Mathematical Literacy, the second draws attention to their experiences both inside and outside of the classroom environment. In this thesis, identity and experiences are focal points as they are important in mutually co-constructing the girls' relationship to Mathematics and Mathematical Literacy.

I continue by considering the implications of this study and conclude with a brief discussion about its limitations.

This study illustrates how doing mathematics is doing gender and furthermore how the association with Mathematics underpins identity work as the category ‘girl’ is lived out amongst sixteen and seventeen year olds. It also illuminates how sexuality is embedded within the doing of gender and how doing Mathematics is not only doing gender but

sexuality as well. The motivation for this study came from my personal experiences as a Mathematics pupil, Mathematics teacher and gender student, and stemmed from numerous university readings and assignments centring on gender and Mathematics. What these readings and assignments drew attention to was the realisation that my previous and current relationship with Mathematics was anything but simple.

The decision to work with Grade 11 girls was two-fold. The improved academic performance of girls in Mathematics, and the narrowing of the gender gaps between boys and girls in Mathematics are issues that have recently been well documented in the media. According to KZN Education Department Superintendent - General Cassius Lubisi (Naidoo, 2006) this gap in performance will probably be a thing of the past by the end of 2008. Although the focus of this study is not on the academic performance of these six girls, it was a necessary starting point. Given that girls seem to be performing as well as boys in Mathematics at school level, why do we still need to concern ourselves with issues of gender and Mathematics? The answer to this question is that it has increasingly become apparent that performance is not the only issue with which we should be concerned when looking at the relationship between gender and Mathematics at school level. Paechter (2001a) argues that girls' enjoyment of and engagement with Mathematics does not seem to have increased with increased success. This thesis focuses on six Grade 11 girls and explores their enjoyment of and engagement with Mathematics.

Secondly, this grade of learners is the first group to be taught under the new Further Education and Training band that emphasizes learner centredness and provides the space and the imperative to engage a much broader notion of what it means to do and succeed in Mathematics (Vithal, 2002). The Revised National Curriculum Statements for Mathematical Literacy seeks as its goal to ensure that the citizens of South Africa are highly numerate consumers of Mathematics. The Further Education and Training subject, Mathematical Literacy, "should enable the learner to become a self-managing person, a contributing worker and a participating citizen in a developing democracy" (Department of Education, 2004, p. 10). The outcomes of Mathematical Literacy are designed to enable

learners to handle with confidence the Mathematics that affects their everyday lives and so be appropriately educated for the modern world. By contrast, the curriculum statements for Core Mathematics highlights that the study of Mathematics is a discipline in its own right and pursues the establishment of knowledge without necessarily requiring application in real life. By acquiring a functioning knowledge of Mathematics, learners are empowered to make sense of society. “Mathematical competence provides access to rewarding activity and contributes to personal, social, scientific and economic development” (Department of Education, 2004, p. 9). The subject Core Mathematics in the Further Education and Training band will provide a platform for linkages to Mathematics in Higher Education institutions. The outcomes specified above show that Mathematics and Mathematical Literacy have very specific outcomes and serve two different groups of learners. The Mathematical curriculum statement continues that “Mathematics is an essential element in the curriculum of any learner who intends to pursue a career in the Physical, Mathematical, Computer, Life, Earth, Space and Environmental Sciences, Technology, Economic, Management and Social Sciences” (p.11). It concludes by stating that if the learner does not intend to follow any one of the above career paths, then they should take Mathematical Literacy.

These two groups of girls form part of a cohort of learners in South Africa who were introduced to the learning areas of Mathematics and Mathematical Literacy at the start of their Grade 10 year in 2006. My interest in working with a group of girls from each learning area was to see what relationship each group constructed with Mathematics, and what relationship the two groups constructed between each other. Further to this, I was interested in understanding how Core Mathematics was being constructed by the girls, particularly as it had replaced the old higher grade Mathematics which had much power, prestige and status invested in it. In light of the above, I wanted to see how Mathematical Literacy was being constructed.

5.2. SYNTHESIS OF ARGUMENT

Mendick (2004) argues that choices are often about identity, and if choices are viewed as part of the process of making identity then the six girls in this study, in choosing, negotiating or rejecting Mathematics or Mathematical Literacy, are telling us stories about who and what they are and are not like, and who and what they do and do not want to be like. In doing so they are drawing on what Mathematics 'is'. Throughout this thesis I have argued that the discourses most central to Mathematics construct it as certain, 'hard', 'rational', 'absolute' and a 'proof of real intelligence'. These discourses are oppositional and gendered because they inscribe Mathematics as masculine. Drawing from Bhana (2005) and Mendick (2004) who share the view that doing Mathematics is doing masculinity, I argue that the girls in this study, in doing Mathematics are doing masculinity and so find it difficult to form a positive association with it. However, it needs to be clarified that the girls in this study do not simply reproduce the idea that Mathematics is masculine and reject it, they work on this.

A number of findings emerged from this study and in the next section I deal with them in a systematic fashion.

5.3. IMPLICATIONS OF THE STUDY

5.3.1. Girls and their overall association with mathematics

What emerged is that all six girls participating in this study had general feelings of dislike towards Mathematics. However, despite this dislike, they did not simply disassociate from Mathematics. What emerged was that their relationship with Mathematics, like my own as shown in Chapter 1, was anything but simple. They spoke of Mathematics as being a source of great anxiety, pressure and in contradiction, enjoyment for them. Not one of them labelled Mathematics or Mathematical Literacy as being their favourite subject. They spoke at length about Art, History and English as their favourites and enjoyed the freedom or expression that these subjects afforded them.

The girls' identities included that of Marine Biologist, Financial Engineer, Writer, Graphic Designer, Art Lecturer and Lawyer, but all six girls' identities excluded that of

Mathematician. These girls see their future careers as reflecting their identity, and see their careers as vehicles for future fulfilment, rather than as simply a stopgap before marriage (Riddell, 1992; Wilkinson & Mulgan, 1995). Although their identities precluded that of Mathematician, the girls quickly pointed out that they understood the importance of studying Mathematics as a means of gaining entrance into a tertiary institution or, using it as a bridging mechanism for entry into a desire career. Some of the girls recognize the strategic power invested in the association with Mathematics in terms of converting their social capital into economic capital. They negotiate and use Mathematics as a tool for future careers. However, it must be noted that as Madison, a Mathematical Literacy girl did, that this association is simply a means to an end.

Whilst I did not focus on teachers in this study, a number of comments made by the participants together with my own observations shows how teachers inscribe within the gender dichotomies thereby reproducing Mathematics as ‘hard’, ‘rational’, ‘a proof of real intelligence’ and ‘masculine’. Bhana’s (2005) study show that right from Foundation Phase, teachers’ constitution of gender and Mathematics/reading in oppositional terms makes it difficult for girls to be identified as good in Mathematics and this has vast implications for Mathematics pedagogy. She writes that many of the ways in which Mathematics is taught in the new curriculum seems to be explicitly designed to discourage girls and argues that doing Mathematics is a significantly gendered site, which influences girls’ ability to develop a relationship with the subject. She emphatically states that Mathematics is distinctively masculine and the discourses around it make the negotiation of gender identities much more favourable towards boys.

Improving girls’ positive associations with and enjoyment of Mathematics and limiting the anxiety and pressure they feel, will not be an easy task as it means eroding the masculine domain that Mathematics has become. This does not mean that Mathematics has an inviolate position and that nothing can be done. Teachers should understand the gendering of Mathematics and seek out ways to explore more fully what this means for girls. Vithal (2002, p. 118) argues that the “need for awareness and action along different

dimensions of diversity is increased for all teachers who take the new curriculum seriously". She continues that gender needs to be addressed in all Mathematics classrooms at all levels for the sake of girls and to achieve the broader societal goals envisaged in the new curriculum.

Unfortunately, an awareness of the gendered nature of Mathematics does not naturally lead to action towards equity and social justice goals. It is important that in the education and training of teachers, right from Foundation Phases through to higher education, teachers must be trained to engage with a much broader notion of what it means to teach and learn Mathematics. It is important for teachers to better understand how Mathematics classrooms can become spaces for challenging gendered patterns and stereotypes found in schools and broader society. If we as teachers understand girls' relationships to Mathematics we cannot but do things differently in the classroom. According to Vithal (2002) teacher training needs to include equipping teachers to challenge and change the deeply gendered nature of roles, responsibilities and activities of girls both inside and outside the Mathematics classroom.

5.3.2. Girls and their relationship to core mathematics and mathematical literacy

The girls in this study relate to two kinds of Mathematics: that of Core Mathematics and that of Mathematical Literacy. Further to this, they relate to Mathematics in terms of the hierarchies and power vested in each. Clearly the power differentials in terms of these two learning areas are contrary to the expected Mathematics policy as laid out in the Revised National Curriculum Statements (Department of Education, 2004). According to this policy, the learning areas of Mathematics and Mathematical Literacy carry the same status as learning areas in the new curriculum. Vithal and Volmink (Vithal et al., 2005) write that a key tension that underlies this new curriculum is the difference between the nature and purpose of Mathematics and Mathematical Literacy. They continue that the insertion of Mathematical Literacy into the curriculum as a foundational subject for learners up to the end of Grade 12 poses a serious challenge with regard to both content and pedagogy, if it is not to be reduced to a watered-down version of Mathematics. At

classroom level as this study has shown, girls have in the short space of a year and a half constructed Mathematical Literacy as being 'soft', 'easy' Mathematics. Certainly in this research context, the implications of what the girls say about other learners, teachers and parents reinforces a watered-down and inferior construction of Mathematical Literacy and this has great implications for Mathematical learning and the construction of gender identity.

The Core Mathematics girls in this study do not simply reproduce the idea of Mathematics as masculine and reject it, they work on this. They use it to their advantage to craft out power for themselves and this shapes how they view themselves, other girls and boys. These 'core girls' create distance between themselves and other girls and boys highlighting differential power relations. The unequal balance of power and the way these girls construct themselves is an indication of the inequalities that are reproduced as core Mathematics is seen as a domain of rationality and intelligence. Core Mathematics has the power to impress and exclude and these core girls use that power to impress teachers, parents and other learners, elevating themselves whilst simultaneously constructing positions of subordination for other girls and boys. At the same time in constructing these unequal relations of power there is a great deal of anxiety, tension and pressure in trying to impress and achieve mathematical prowess and, primarily power. Further inequalities are reproduced as the Mathematical Literacy girls subordinate themselves and are subordinated by the power and prestige of Core Mathematics.

What can the department of education do in terms of supporting the policy as stipulated? Perhaps the department, together with its educators need to revise the content and review the manner in which Mathematical Literacy is taught in order to rescue it from its depreciating status of 'soft', easy Mathematics and therefore a source of inequity. This appears to be happening already as emerging research and analysis shows that learners taking Core Mathematics may not be able to do some of the Mathematical Literacy activities depending on how teachers interpret and implement the Mathematical Literacy curriculum.

The problem of Mathematical Literacy being seen as a lower level of Core Mathematics rather than a different kind of Mathematics with its own specific outcomes is compounded by the fact some of the universities here in South Africa have closed off a number of degrees to learners that have taken Mathematical Literacy at school. This reinforces that there is in fact a significant difference between the level of skill required for Core Mathematics and Mathematical Literacy. Prior to 2008 learners were able to secure a position at most universities and in most degrees with a good standard grade Mathematics pass. Learners, teachers and parents all recognised that although standard grade Mathematics was a lower level of Mathematics, it still gave learners the choice of attending a university and obtaining a degree. Standard grade Mathematics still carried some status. The matric class of 2008 no longer has this choice as they are forced into taking Mathematical Literacy if they cannot cope with Core Mathematics. And as is highlighted from the data collected in this study, learners see this move from Core Mathematics to Mathematical Literacy as “dropping to Mathematical Literacy” thus reinforcing in their minds that Mathematical Literacy is a lower level of Mathematics with a lower educational value and status. What needs to be reinforced is that Mathematical Literacy is a different kind of Mathematics with its own specific aims and objectives and not a lower level of Core Mathematics.

5.3.3. Doing mathematics is not only doing gender, but sexuality as well

For the girls in this study, doing Mathematics is not only doing gender but doing sexuality as well. The girls in this study actively negotiate their sexual identities with their learner identities. Epstein & Johnson (1998) write that sexuality and sexual differences are not only socially produced, they are also invested with power. For Nadiya, Rehana and Juliet, the three Core Mathematics girls, a boy’s Mathematical ability is more important than his looks, macho masculinities or sporty masculinities. For these three core girls Mathematics is money, status and power and that added together equates to sex appeal. The three core girls associate with Mathematics in ways that engenders success and for all three of these girls success in Mathematics is also seen to be heterosexually desirable. For

these girls boys who are not clever in Mathematics hold no sexual appeal and thus for them, being clever in Mathematics is a key marker of desirability and sexuality. For these core girls Mathematical capital plus economic capital equals sexual and social capital, and this is an important equation in terms of who these girls see as potential boyfriends. In contrast, for Chrystal, Abigail and Madison, the Mathematical Literacy girls, whether a boy was good at, bad at or didn't do Mathematics at all was unimportant. For them Mathematical ability does not equate to sex appeal. The sporty masculinity appealed more to them, particularly Madison and Abigail. What this highlights is a big difference in the sexual identities of the two groups of girls. The Core Mathematics girls openly stated that they had very high standards in terms of who they would consider as a potential boyfriend. For them, a boy who takes Mathematical Literacy would not even be considered as boyfriend material.

Rehana, a Core Mathematics girl, spoke about the tensions, contradictions and pleasures as she negotiated the pushes and pulls of being both 'bright', succeeding Mathematically, and the power of being 'beautiful', succeeding in "doing girl". In contrast Juliet, also a Core Mathematics girl, tried to down play her sexuality and celebrated her academic status. Academic excellence took its place alongside, and was negotiated within, broader social and cultural norms that made up her notion of "being a girl". Although Juliet's story is about individually pursuing academic excellence and ditching conventional hyper-femininity and all that it entails, she does contradict this in documenting her relationship with Romeo where she clearly displays that for her, sexuality and Mathematics are inextricably interwoven.

What this study has shown is how these three Core Mathematics girls rise to the challenge of Mathematics, yet can negotiate their sexuality in strikingly different ways. It also shows the difference in the sexual identities of the core girls and the lit girls and reinforces the unequal power relations between the two groups. The power and status that the core girls get from their association with Mathematics allows them to be selective in

terms of whom they find desirable, whereas for the lit girls as Chrystal states “I would go out with any guy”. Sexuality shapes and is shaped by all the surrounding social relations.

Indeed it is difficult to know where sexuality begins or ends. [It] enters the power relations of schooling but it is also present in the patterns of personal friendships and relationships; fantasies and expectations about future destinies. (Epstein & Johnson, 1998, p. 114)

When attempting to unpack these girls’ very complex relationship with Mathematics, it becomes essential to explore how sexuality is an integral part of this relationship. However, this may prove challenging as it has been well documented that “putting the terms ‘schooling’ and ‘sexuality’ together is the stuff of which scandal can be, and often is, made” (Epstein & Johnson, 1998, p.1). As teachers, we try very hard to keep sexuality out of the school environment and only deal with when it becomes an essential part of the academic curriculum.

5.3.4. The power and prestige of Mathematics in terms of race and class

According to Walkerdine (1990) parents of middle to upper-middle class children send out an unspoken message from birth that not only are they able and clever, but that it is their destiny to go to university and become professionals. In middle-class families there is an enormous fear of failure, of falling off the middle-class conveyor belt. The parents of these six girls are also a source of difference in the construction of Mathematics. Some parents produce anxiety in their daughters as these girls have to live up to standards expected by their race and class. While the two Indian girls, Rehana and Nadiya, spoke of the status afforded to Mathematics in the Indian community, both girls stressed that their parents did not put added pressure on them to take these subjects. Both girls have attended extra tuition in mathematics and physics since the beginning of Grade 10, just to help them ‘get ahead’. These two girls have invested in and enjoy the power and prestige that Mathematics affords them, particularly in the upper-middle class Indian community.

Other parents merely allow their daughters to give up on Mathematics as they notice the anxiety, struggle and pressure their child is under and accept that Mathematics is simply

too hard to do. What schools need to do is bring parents into the picture and work with them, changing the focus from solely being results orientated to embrace the outcomes of the new Further Education and Training band that downplays the importance of academic results and highlights that all the learning areas, in policy, carry the same status.

This provides a contradiction in terms of what policy is saying and what parents and learners themselves want. The Revised National Curriculum Statements are arguing for the instilling of skills, attitudes, values and knowledge. However, parents and learners in this school context are only interested in the academic results that will provide the means to a future career. Both middle-class parents and their children share the same view of education as a means to a lucrative end. Changing this view is going to prove to be a very difficult task in light of the fact that many middle class parents and their children are acutely aware of the ever increasing problem of unemployment here in South Africa. Both parents and learners are only interested in what needs to be done to improve academic results in order to secure a position in a tertiary educational institution and ensure upward social and economic mobility. In light of the careers that Mathematics provides access to as stated in the Revised National Curriculum Statements above, not many options remain for learners of Mathematical Literacy. Parents are going to insist that their children take Mathematics even if it is a source of great anxiety and discomfort for them. Based on my observations and conversations with these six girls, this is already happening at Glenville College, where parents are fighting with their children and the teachers in order for their daughter or son to remain in the Mathematics class even though they cannot cope with the work. As troubling as these above comments may be, one cannot deny that this is the way that parents, teachers and learners in this specific school feel. Core Mathematics and Mathematical Literacy are most definitely being seen by learners and parents as two different levels rather than two different kinds of Mathematics at Glenville College.

5.3.5. Access to better resources does not ensure a more positive relationship with Mathematics

In concluding the findings of this study, it is false to assume that the girls from resource-rich contexts will automatically have a more positive association and better relationship with hard core subjects like Mathematics. These girls have been made invisible from the Mathematics education literature particularly in a South African context, as it is assumed that they have it all and that all is well in terms of girls and Mathematics in these contexts. This is clearly not the case as this study shows. The power of Mathematics to impress and exclude has great ramifications even in a school like Glenville College.

5.4. LIMITATIONS OF THE STUDY

A limitation of this study is that the selection of participants could have been different. However, as mentioned previously no Black girls were available to participate in this study. Participants could have been more carefully selected paying close attention to broader race/culture, class/family educational backgrounds. This diversity may have produced a different/stronger analysis.

5.5. CONCLUSION

Finding solutions to the problems raised by these findings, is not an impossible task but one that will present challenges. It is not as simple as abolishing the discourses around Mathematics. Mendick (2004, p. 204) writes that the social and historical practices of Mathematics have resulted in a great deal more than oppression and inequality. She continues that just as masculinity is not all bad, neither is Mathematics. What she suggests is that there is a need to reconstitute Mathematics on new bases, the possibility of “separating the cultural energy around Mathematics from the structures of inequality” (p.204). In order to reconstitute Mathematics, we need to change the myth of the certainty of Mathematical knowledge, and its epistemological status as absolute and rational. It is this that gives Mathematics its power and maintains its position as the ultimate intelligence test. We need to see a more inclusive and socially just mathematical curriculum, supported

by content and pedagogy, in which more learners than at present could come to think of themselves as authorities in relation to Mathematics.

Access to Mathematics is about more than just meeting the country's economic needs. If girls like the six in this study are constructing relationships with Mathematics in ways that are imbricated in social factors such as gender, class and race then this presents a real challenge for the South African government who has gone to great lengths to put policies and initiatives like the White Paper on Education (Department of Education, 1995), the Science Education Project in South Africa (Mthiyane, 2007) and the Girls Education Movement (Fester, 2004) into place. They have coupled the above initiatives with making Mathematics a compulsory learning area up to the end of Grade 12 in order to ensure a greater production of girls into the arenas of Mathematics and Science. However, if these six girls, who have had the barriers to education removed (Morrell, 1992) do not form positive associations with Mathematics, how much more difficult will it be for girls who experience abject schooling conditions to develop a positive association with it and wish to pursue it further. What this research has shown is that the argument is anything but linear and simple. By making Mathematics a compulsory learning area, it may increase academic success and force girls to remain in the subject for longer. It certainly does not mean, as this study has shown, increased enjoyment of the subject. All six girls spoke of not really enjoying Core Mathematics and the anxiety and pressure associated with learning it. The three Mathematical Literacy girls spoke of enjoying Mathematical Literacy and that they did not have the same anxiety and pressure as the girls who did Core Mathematics. These lit girls spoke of being able to enjoy Mathematical Literacy and do well in it. They did not have to push themselves to do something they did not want to do.

Very few of the girls and boys from Glenville College have chosen to or are able to meet the required standard and remain on Core Mathematics. In this small, well-resourced and well-staffed school many learners, not only girls, are opting out of Core Mathematics in favour of the easier Mathematical Literacy route. Looking at the degrees that Mathematics provides access to, one can see that not many options are left for learners who are opting to

take Mathematical Literacy. By doing so, they are in effect closing a number of doors to future careers and this is in no way going to stem the tide of wasted talent, particularly amongst girls, in the lucrative areas of Mathematics and Science. In fact this is going to hinder South Africa's commitment of getting more women into the fields of Mathematics and Science.

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APENDIX 1

SCHEDULE OF ACADEMIC RESULTS FOR PARTICIPANTS

CORE MATHEMATICS GIRLS

2007 ACADEMIC YEAR

TERM 1 – GRADE 11

NAME	ENGLISH	AFRIKAANS	ISIZULU	MATHEMATICS	MATHEMATICAL LITERACY	LIFE ORIENTATION	LIFE SCIENCE	PHYSICAL SCIENCE	HISTORY	ACCOUNTING	VISUAL ART	COMPUTERS
<i>NADIYA</i>	71		81	38		66	78	60	92			
<i>REHANA</i>	70	81		64		77		76	88	87		
<i>JULIET</i>	92	98		65		74	88	65	92			

MATHEMATICAL LITERACY GIRLS

2007 ACADEMIC YEAR

TERM 1 – GRADE 11

NAME	ENGLISH	AFRIKAANS	ISIZULU	MATHEMATICS	MATHEMATICAL LITERACY	LIFE ORIENTATION	LIFE SCIENCE	PHYSICAL SCIENCE	HISTORY	ACCOUNTING	VISUAL ART	COMPUTERS
<i>CHRYSTAL</i>	50	65			76	68			53		67	75
<i>ABIGAIL</i>	50	63			64	63	74		54		72	71
<i>MADISON</i>	66	81			80	86	84		76		68	

APPENDIX 2

15th September 2006

The Principal
Glenville College
Durban

Dear Sir

RE: Permission to conduct research at Glenville College

As you are aware, I registered for my Master's Degree in Education at the beginning of 2006. I completed my Honours degree specializing in Gender and Education, and I have pursued my Master's in the same specialization.

My area of interest is specifically in Gender and Mathematics and the impact that this has on girls. With the new FET in place and Mathematics/Mathematics Literacy being a core subject I wish to explore how girls construct their gendered identities in relation to Mathematics. I believe that unless girls incorporate Mathematics positively into their identity work it will be difficult for them to feel comfortable in and achieve at compulsory mathematics.

I have randomly selected two girls from each of the Mathematics classes, presently grade 10, but moving into grade 11 next year. These selections are only temporary as I realize the girls may move into different groups in 2007. The best method to gain the data that I need would come from semi – structured interviews and to observe the participants in the Mathematics classrooms. I only plan to collect this data over a three week period in term 1 of 2007.

Would it be possible to conduct this type of data collection in the school? I am conscious of not disrupting the normal teaching programme, and my primary focus is not on the teachers, but the girls themselves. The finding of my observation and interviews will be completely confidential and under no circumstances will these finding be used in any comparative study. I undertake to protect the identity of the school and the participants at all times.

If you would like to meet with me to discuss any concerns that you might have regarding my intended study, I would be more than happy to meet with you.

If you would like confirmation of my intended study, please feel free to contact my supervisor at the University of KwaZulu – Natal. Her details are as follows:

Professor Deevia Bhana
(031) 260 2603
Bhanad1@ukzn.ac.za

Yours Sincerely
Charmaine M Vermeulen

APPENDIX 3

PRIVATE & CONFIDENTIAL

Mrs C Vermeulen
58 Tivoli
10 Lilyvale Rd
Ashley
Pinetown. 3610.

19th November, 2006.

Dear Mrs Vermeulen,

RE: PERMISSION TO CONDUCT RESEARCH.

I acknowledge receipt of your letter dated 15th September 2006 in connection with the above matter and have noted its contents.

I have noted the description of the research which you propose undertaking in our school and I am satisfied that conducting this research will not be harmful or detrimental to the school or its learners in any way.

Accordingly I consent to your request to undertake the research as stipulated in your letter during the course of 2007 and 2008 if necessary. The research will, of course, be dependent upon the willingness of individual teachers to participate where necessary.

I wish you success with your research.

Yours sincerely,



Principal.

APPENDIX 4

25TH April 2007

Dear Colleague

RE: RESEARCH DATA COLLECTION - PARTICIPANT OBSERVATION

As you know by now I am in the final year of my Master of Education degree, specializing in gender and education. The focus of my research is on **exploring the ways that grade 11 girls in a private coeducational school construct their relationship with Mathematics and Mathematical Literacy.**

Two of the methods that I am using to collect data are; semi-structured interviews and participant observation in the learning environment of the classroom. Participant observation requires that I observe each of my participants in the environment of their Mathematics/Mathematical Literacy classroom. Each observation is 1 hour or a double period. I have three participants in the Mathematics classroom and three in the Mathematical Literacy classroom.

I give you my assurance that I am only interested in focusing on each of my participants and at no time is the observation directed at you or the other learners in the class. I have sought informed consent from each of the participants and they are fully aware that I will be coming to observe them. They however, do not know the specific lessons that I will be observing. I am aware that my presence in your classroom will alter the dynamic/environment, but that is beyond my control and I will have to factor this into my analysis of the data collected.

With your permission, I would like to come in and observe during the following lessons:

Date and lesson number:

Date and lesson number:

Date and lesson number:

The data collected from my observations will be completely confidential and in referring to your classroom environment I will be using a pseudonym for you. If at any time reference is made to you, I will have to seek your permission and informed consent. I am also obliged to show you any incidental data that may be collected on you if it so arises, for you to read and approve of. This should not happen as the focus of my data collection is on the participants. I also fully understand and accept that you can deny me access to your classroom and I have to respect that decision should you make it at all times. The principal has granted me permission to conduct research in the school, but made it very clear that in order to conduct observations; I had to get permission from the teacher concerned.

Thank you very much and if you require further information regarding this study please feel free to ask me or contact my supervisor at the University of KwaZulu-Natal. Her details are as follows:

Professor Deevia Bhana
Faculty of education
(031) 260 2603
Bhanad1@ukzn.ac.za

Thank you very much
Yours sincerely
Charmaine Vermeulen
914365271

APPENDIX 5

To: Mrs Vermeulen

The reason I did not wish to participate in your research was because I felt that I might feel intimidated knowing that someone would be watching me during maths lessons. Due to that feeling, it could cause a lack of performance of my ability during my maths lessons.

Ameetha Naidoo (pseudonym)

APPENDIX 6

Invitation

Dear Participant

*Please would you join me for a getting to know you better
"tea and cake party"*

Date: Wednesday 21st March 2007

Time: 10h00

Venue: Blue Zoo tea garden at Mitchel Park

*If you need a lift home afterwards, please let me know and
I will be more than happy to take you.*

*P.S. If possible please could you bring along something that
reminds you of Mathematics. It must be something
that I can keep for a while - so not your maths books*

I am looking forward to spending this time with you.

Fond regards

Charmaine

APPENDIX 7

February 2007

Dear Participant

As you may know, I am presently studying for a MEd in Education at the Faculty of Education, University of KwaZulu – Natal. I am focusing my research for this degree on exploring **the ways in which private school girls in grade 11 construct their relationship to Mathematics**. I am particularly interested in finding out how girls in the specific ability groups of Core Mathematics and Mathematical Literacy develop and construct their relationship to Mathematics.

At our group discussion last week, I gave all the grade 11 girls the opportunity to remove themselves from the selection process and assured you all that your non - participation would in no way affect my opinion of you in the future.

Your participation in this research project will require that you be involved in the following activities:

1. An interview/conversation with me that will last for approximately between 30 minutes and 1 hour. At the moment, I plan to only have one interview with each participant, but should an interesting issue or idea arise that I would like more information on, I may ask you for a follow up interview/conversation session. In these interview/conversations, I am interested in hearing your opinions and ideas about mathematics. I will ask for your permission to record these interviews onto an audiotape.
2. I am conscious of the fact that your academic and sporting commitments will take precedence over my research, however if time allows, I would like you to keep a simple journal in which you record any ideas, experiences, thoughts or events that have occurred and that have been important to you and your experience of school Mathematics.

Your participation in my research project will also involve me observing you in the environment of your Mathematics/Mathematical Literacy classroom in order to observe how you interact with your fellow learners, your teacher and how you experience the natural environment of the classroom. I do not intend to make you feel uncomfortable and under no circumstances will your teacher or fellow learners know the purpose of my visits to your classroom, unless you choose to divulge this information to them. As a participant, you will be aware of my presence in your Mathematics classroom, but in order to minimize the disruption to your learning programme, I felt it may be better for you not to know during which lesson I will be observing you. Owing to time constraints, I have budgeted on only observing each participant twice.

I plan to draw on audiotapes of the interviews and group discussions, your journals, and my observations of you in the classroom environment as evidence for my MEd research. I will only refer to your written and spoken words and my observations of your participation if I receive written consent from you. Once I have analysed the data collected and re-written them into your mathematical story, I will return the story to you for you to approve of its contents.

If I receive your consent, I will draw upon your written and spoken words and my observations in a way that respects your dignity and privacy. Your name or any information that might identify you directly will not be used in the MEd thesis or any other presentation or publication that might come out of the study. Copies of your written work, audiotapes of interviews and discussions, and my observations will be securely stored and disposed of if no longer required for research purposes.

I cannot offer you any material benefit from participating in my study, but perhaps your involvement may assist you to view yourself, and the relationship you have constructed with Mathematics in a different light.

It is important for me to emphasize that your participation in my study is completely voluntary and that you are free to withdraw from participating at any time should you so desire. Your decision to withdraw from the

study will in no way influence my continued relationship with you and will not result in any form of disadvantage.

I would appreciate it if you could take some time to consider my request and then complete, sign and return this letter to me. I will then give you a copy of the completed letter. Should you need any issues clarified or explained, please do not hesitate to come and speak to me or contact my supervisor at the University of KwaZulu – Natal on the following details:

Charmaine Vermeulen
charmainev@sthenrys.co.za
(031) 261 7369

Professor Deevia Bhana
Bhanad1@ukzn.ac.za
Work – (031) 260 2603

Thank you very much.
Yours sincerely

Charmaine Vermeulen

Professor Deevia Bhana

DECLARATION

I (full names of participant) hereby confirm that I understand the contents of this letter and the nature of the MEd research, and

GIVE	DO NOT GIVE
------	-------------

(tick one) my consent for Charmaine Vermeulen to use my written and spoken words and her observations of my participation in the Mathematics lessons as evidence for her MEd research and any other presentation or publication that might come out of the study.

I understand that I can revise my decision at any time.

Signature of participant: _____

Date: _____

Contact details of participant:

APPENDIX 8

February 2007

Dear Parents

As you may have heard from your daughter, I am presently studying for a MEd in Education at the Faculty of Education, University of KwaZulu – Natal. I completed my Honours degree specializing in Gender and Education, and I have pursued my Master's in the same specialization.

My area of interest is specifically in Gender and Mathematics and the impact that this has on girls. With the new FET in place and Mathematics/Mathematical Literacy being a core subject I wish to explore how girls construct their gendered identities in relation to Mathematics. I believe that unless girls incorporate Mathematics positively into their identity work it will be very difficult for them to feel comfortable in and achieve at compulsory Mathematics.

The focus of my intended research for this degree is on exploring **the ways in which private school girls in grade 11 construct their relationship to Mathematics**. I am particularly interested in finding out how girls in the specific ability groups of Core Mathematics and Mathematical Literacy develop and construct their relationship to Mathematics.

At a group discussion last week, I gave all the grade 11 girls the opportunity to remove themselves from the selection process and assured them all that their non - participation would in no way affect my opinion of them or disadvantage them in anyway in the future. After I had the names of all the learners who were willing to participate in my research, I randomly selected the participants by placing all the names into an envelope and drawing out six. Your daughter's name was one of the six that I drew.

Your daughter's participation in this research project will require that she be involved in the following activity:

- An interview/conversation with me that will last for approximately between 30 minutes and 1 hour. At the moment, I plan to only have one interview with each participant, but should an interesting issue or idea arise that I would like more information on, I may ask for a follow up interview/conversation session. In these interview/conversations, I am interested in hearing your daughter's opinions and ideas about Mathematics. I will ask for her permission to record these interviews onto an audiotape.

I am conscious of the fact that you would be concerned about how your daughter's participation in this project may affect her academic and sporting commitments. All academic and sporting commitments will take precedence over my research and all interviews and group discussions will take place after school hours and at a time that will be suitable to both your daughter and yourselves. I undertake that neither your daughter nor you will be inconvenienced by this research project. I will adapt and suit the methods to accommodate all the participants' schedules and commitments.

Your daughter's participation in my research project will also involve me observing her in the environment of her Mathematics/Mathematical literacy classroom in order to observe how she interacts with her fellow learners, her teacher and how she experiences the natural environment of the classroom. I do not intend to make your daughter feel uncomfortable and under no circumstances will her teacher or fellow learners know the purpose of my visits to the classroom, unless your daughter chooses to divulge this information to them. As a participant, your daughter will be aware of my presence in your Mathematics classroom, but in order to minimize the disruption to her learning programme, I felt it may be better for her not to know during which lesson I will be observing her. Owing to time constraints, I have budgeted on only observing each participant twice.

I plan to draw on audiotapes of the interviews and group discussions, journals, and my observations of your daughter in the classroom environment as evidence for my MEd research. I will only refer to her written and spoken words and my observations of her participation if I receive written consent from you. Once I have analysed the data collected and re-written them into your daughter's specific mathematical story, I will return the story to her for her approval of its contents.

If I receive your consent, I will draw upon your daughter's written and spoken words and my observations in a way that respects her dignity and privacy and that of your family too. Your daughter's name or any information that might identify her or the school directly will not be used in the MEd thesis or any other presentation or publication that might come out of the study. Copies of your daughter's written work, audiotapes of interviews and discussions, and my observations will be securely stored and disposed of if no longer required for research purposes.

I cannot offer your daughter any material benefit from participating in my study, but perhaps her involvement may assist her to view herself, and the relationship she has constructed with Mathematics in a different light.

It is important for me to emphasize that your daughter's participation in my study is completely voluntary and that she is free to withdraw from participating at any time should she so desire. Her decision to withdraw from the study will in no way influence my continued relationship with her and will not result in any form of disadvantage during her future school career. The College Principal is fully aware of the nature, purpose and details of my intended research project, and has made the school available to me as a site to conduct research. This is on condition that I obtain informed consent from both my participants and their parents.

I would appreciate it if you could take some time to consider my request and then complete, sign and return this letter to me. I will then give you a copy of the completed letter. Should you need any issues clarified or explained, please do not hesitate to contact me or my supervisor at the University of KwaZulu – Natal on the following details:

Charmaine Vermeulen
charmainev@sthenrys.co.za
(031) 261 7369

Professor Deevia Bhana
Bhanad1@ukzn.ac.za
Work – (031) 260 2603

Thank you very much.
Yours sincerely

Charmaine Vermeulen

Professor Deevia Bhana

DECLARATION

I (name of parent)
hereby confirm that I understand the contents of this letter and the nature of the MEd research, and

GIVE	DO NOT GIVE
------	-------------

(tick one) my consent for Charmaine Vermeulen to observe/interview my daughter in her Mathematics lessons as evidence for her MEd research and any other presentation or publication that might come out of the study.

I understand that I can revise my decision at any time.

Signature of parent: _____

Date: _____

APPENDIX 9

25th April 2007

Dear Participant

RE: PARTICIPANT OBSERVATION/INTERVIEW DATE AND TIME

As you know by now, I am in the final year of my Master of education degree specializing in gender and education. The focus of my research is on **exploring the ways that grade 11 girls in a private coeducational school construct their relationship with Mathematics and Mathematical literacy.**

Two of the methods that I am using to collect data are; semi-structured interviews and participant observation in the learning environment of the classroom. Participant observation requires that I observe each of my participants in the environment of their Mathematics/Mathematical Literacy classroom. Each observation is 1 hour and our semi-structured conversation (interview) should be roughly 45 minutes to an hour depending on the in-depth nature of the conversation.

After our discussion at Blue Zoo, you are aware that I will be coming to observe you at some time during the following month. You do not know the specific lesson that I will be coming in to observe as I feel that this will have less of an impact on you and perhaps alleviate some of the stress you will feel about being 'watched'. I am aware that my presence in your classroom will alter the dynamics of the classroom, but that will be something that I will have to factor into and take account of in my analysis. All I am interested in observing is how you interact in the classroom environment. So I would like you as far as possible, and I am aware that this is not going to be easy to do, to ignore my presence and simply continue with your learning programme.

I have set aside the following date, time and venue for our 'conversation' and I undertook to avoid clashing with your extra-mural programme as far as possible. This has unfortunately not been possible as you are all so fully committed in the life of the school. If there is a clash, I will excuse you personally from the teacher-in-charge of that activity. If the date and time do not suit you please let me know and we can then work out an alternative around your schedule:

Date:

Time:

Venue:

The data collected from the observations and interviews will be completely confidential, and in referring to you I will be using a pseudonym, as I undertook to do and am obliged to protect your identity at all times. I have sought your permission and informed consent previously, but I need to remind you that you are completely free to withdraw from this study at any time and this will not be held against you now or in the future. I am also obliged to show you any data that I have collected on you for you to read and approve of. Once I have written up the interviews and observations, I will be giving them back to you to read and verify.

Thank you again for being so willing to participate, if it was not for you my research would never have been possible. If you or your parents need any further information about my research please feel free to contact me or my supervisor at the University of KwaZulu-Natal. The contact details for both are:

Professor Deevia Bhana
Faculty of Education
(031) 260 2603
Bhanad1@ukzn.ac.za

Charmaine Vermeulen
charmainev@sthenrys.co.za
(031) 261 7369

Thank you very much
Charmaine (914365271)

APPENDIX 10
SEMI – STRUCTURED INTERVIEW SCHEDULE

DURATION: A minimum of 30 minutes to a maximum of 1 hour.

1. Before we begin this interview, I need to assure you that all that is said will be kept confidential and that your anonymity will be protected at all costs, unless you choose otherwise.
2. During our pre – data collection conversation, I asked for your permission to audiotape our interview/conversation. Do I still have your permission?
3. I need to remind you that you are free to withdraw from this research at any time without any disadvantage. I will not hold your decision to withdraw against you; neither will it disadvantage your future career here at the school.

I am going to start by asking you some questions about your **experiences of mathematics lessons**.

1. Describe a typical maths lesson, what do you do and how do you feel?
2. What have you enjoyed most about your maths lessons this year and why?

Prompts: Are there specific topics?
Are there specific lessons?
Not only this year, from last year as well.
The way in which you were taught?
Specific teacher(s)

3. What have you enjoyed least about your maths lessons this year and why?

Prompts: Are there specific topics?
Are there specific lessons?
Not only from this year, from last year as well.
The way in which you were taught?
Specific teacher(s)

The next set of questions are about **teaching and learning in mathematics**.

4. Thinking about yourself as a learner, can you tell me something at all about how you learn best?
5. Can you say something at all about the learning approach that you specifically use in mathematics.

Prompts: How do these compare to other subjects?
Explore the reasons for the differences

6. Would you classify yourself as being bad at maths/ good at maths or really good at maths? Why?

Prompts: Explore reasons

7. Do you usually work with other people or individually in class or on your homework?

Prompts: How does this compare with your other subjects?
Explore reasons further for differences.

Now I want you to think about the **nature of mathematics as a subject.**

8. Do you think that maths is more about learning steps and rules or about understanding why the rules work?

9. Which of your other subjects is most like maths?

Prompts: Why? Do you think this has anything to do with the image of Mathematics?

10. Which of your other subjects is the most unlike mathematics?

Prompts: Why? What is the image of this subject

The next set of questions focuses on **mathematics and sexuality.**

11. Would you “go out with/date” any of the boys in the Mathematics Literacy/ Mathematics class?

Probe: Why/Why not?

12. What if anything, can you recall the boys in your class saying about the girls and Mathematics?

Probe: How did this make you feel?

13. How do you think the girls who take Mathematical Literacy/Mathematics feel about you?

Prompts: What do they think about you?
Stigma attached
Why? Explore

“A question of choice”, these questions relate **to the subject choices that you have made.**

14. How do you feel about Mathematical Literacy/Mathematics being a core subject?

Prompts: Explore the issue of being forced into the subject
Why? Tell me more

15. What other subjects are you doing? Which of them do you like best?

16. Why did you choose them?

Prompts: **Good at them/Enjoy them/Parents, teachers, peers pressure**
Career plans

17. What do you hope to do after you finish grade 12?

Prompts: **University/tertiary studies**
Employment
Involvement in mathematic

As you know I am very interested in Gender, so the next three questions are going to **focus on your ideas and opinions on gender.**

18. How do you feel and what do you think when so many people say that “boys are naturally better at mathematics than girls”?

Prompts: **Agree/Disagree**
Teachers beliefs/Peer influence/Parent influence
Own results

19. Do you think that being a female makes a difference to your life generally in any way?

20. Do you think that you would have answered question 19 differently if you had attended an all girls’ school?

APPENDIX 11

ABRIDGED VERSION OF OBSERVATION SCHEDULE

GRADE 11: Mathematics/ Mathematical Literacy

Group:

Date and time:

Teacher:

Focus of Observation:

Resources:

Classroom plan:	Lesson structure and timings:

Classroom surroundings:

Classroom interaction:

General comments:

Specifics: be descriptive, note time, settings, words used, body language, interactions,
Etc.

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23 MARCH 2007

MRS. CM VERMEULEN (914365271)
EDUCATION STUDIES

Dear Mrs. Vermeulen

ETHICAL CLEARANCE APPROVAL NUMBER: HSS/0103/07M

I wish to confirm that ethical clearance has been granted for the following project:

“To explore the ways in which private school girls in grade 11 construct their relationship to mathematics”

Yours faithfully

A handwritten signature in black ink, appearing to read 'Phumelele Ximba', written over a dotted line.

MS. PHUMELELE XIMBA
RESEARCH OFFICE

cc. Faculty Research Office (Derek Buchler)
cc. Supervisor (Prof. D Bhana)

2007-03-27