# Paradox, Partiality and Promise:
## A politics for girls in school mathematics

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# Abstract

This study explores the question of girls in school mathematics through gendered subjectivity. Its theoretical and empirical approach provides a different analysis and sketches an alternative politics for girls in mathematics, not only in its vision but also in the level and style of intervention it advocates. Using ideas drawn from poststructuralist theory and linking these ideas to the political agendas of feminism, it examines, in the first place, how the girl became an historical problem for mathematics education. Its point of departure then shifts the focus of the girl away from an epistemological account of identity to one which constitutes the girl within practices and discourses. Following from this, and by describing how gender is enacted around school mathematics, an alternative approach to knowledge of gendered schooling is developed and new spaces are created for political work in the field.

# Acknowledgments

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# FOREWORD:

## Opening the I/eye
or
## Locating the writing

> What is an educational system, after all, if not a ritualisation of the word; if not a qualification of some fixing of roles for speakers; if not the constitution of a (diffuse) doctrinal group; if not a distribution and appropriation of discourse, with all its learning and powers? What is 'writing'...if not a similar form of subjection, perhaps taking different forms, but nonetheless analogous? (Foucault, 1972, p127)

Foucault[1] marks my point of entry into this text, but his reference should be taken merely as my textual beginning. If this work did indeed once have a starting point it has since been lost long ago in the arbitrariness and turmoil surrounding its production. But what is clear to me that the years in which I spent working as a secondary school teacher of mathematics in some ways have motivated its development. In that particular period it became easy for me to believe that my teaching practice had nothing useful to say to girls about their place in politics. That belief arose precisely from the physical demands made upon the practice of teaching. The actual activity of thinking and researching about theories that might inform my practice had to be postponed until this project.

But there are more urgent questions than this work's points of origin that intrude on this undertaking. In opening with Foucault I want to draw attention to the activity of writing. That my reference to his work marks a deviation from more usual beginnings should not be read as a random choice of beginnings on my part. Granted that the more usual way of beginning would outline what the research is all about, what the research intentions are, why it matters, and how it relates to other mathematics educational projects, taken together, these matters do not demand my immediate attention. I want to forestall such discussion until later in order to attend to the critical concerns that the activity of writing makes upon this project.

Foucault requires my urgent response when he suggests that writing as a mode of activity is a form of subjection. Raising the question of the relationship between writing and politics brings to the fore a whole set of issues about the complicity of writing in various forms of disciplinary power. It draws attention to the activity of writing as a governed site, simultaneously constrained and enabled by formal and informal rules which are

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1       Foucault is one of a group of thinkers commonly associated with French poststructuralism. His commitment was to an anti-idealist programme which holds that "truth is of this world". But his interests extend beyond methodological concerns to a fascination in the mechanisms of power in modern society and herein lies his unique contribution to social theory, namely, his ability to beaver out the manifestations of power where few before him had thought to look.

institutionalised by means of explicit statements or implicit assumptions through specific practices. To talk of writing in this way is to suggest then that all written work is a textual economy and in contextualising this piece of work in this manner I hope to address more adequately the question of where it places itself and for whom it is written.

Where does the writing of this particular text place itself? Whom does it address? This is a report of my work within the discipline of mathematics education. It is of a specific type, framed by the formal requirements of an institutionalised practice. That practice is the production of a doctoral thesis. Its writing is a context bound form of textual production, subject to constraints and enablements from its specific textual economy, the academy. The subject/text it constructs is governed by particular rules that have a history long before it makes its appearance. It is subjected to structuring and technologies of production to the extent that its production is, to paraphrase Bakhtin (1981), overpopulated with others' intentions.

And who am I, the writer of this text? This is written by one trained in mathematics and in education and who desires to be read by the discipline of mathematics education. But it is not confined exclusively to the discursive field of mathematics education. When I write about my field of study it is in light of what others have already said, both within and beyond the discipline. These 'others' can be seen through my writing practices. They mark a characteristic position for me by valorising a set of devices, protocols and conventions for writing. They offer analytic strategies in providing the techniques, the assumptions, priorities and methods, the questions and the terms of the analysis. They enable connections and exclusions to be made, traits to be established and continuities to be recognised. In short they offer a set of discursive strategies that might affirm the writing's status within mathematics education.

While I can say that these 'others' mark some characteristic position for me, I cannot say that they mark the 'truth'. To do so would be to bind the writer to self-presence and stability and argue for the theoretical legitimacy of the objective and disinterested researcher/writer. But there are more valid subject positions than the objective modernist narrator. To say that I have read on the subject and to write using strategies that are 'party' to the appropriate demands, is to raise the question of politics. Have I read and written about the 'right' people, in the 'right' manner? When we approach the issue in this way it is possible to claim that, in the act of writing, the writer is intimately tied to an institutionalised academic endeavour. I, the writer of this text, cannot claim to be the source of authority and guarantor of meaning since I am, with regard to the question of

my thesis proposition, persistently responsible, in the Derridean[2] sense to the trace of the 'other', the academic institution.

> My discursive strategy cannot be dissociated from the place of enunciation and the enunciative, textual game in which I am involved. The thinking/speaking "I" which signs this paper is neither the owner nor the king of the complex network of meanings that constitute the text. (Braidotti, 1989, p93)

There is much in my writing that eludes the logic of 'absolute and true' interpretation. If I hope to map my project onto some sort of 'readable' position I have to situate myself and my project in relation to anterior texts, theories and approaches. And even though I write as an apparent self-present subject, of something unified and whole, something in the writing will always have been suppressed in order to sustain the appearance of unity. When I make distinctions among events and differentiate the networks and levels to which these events belong and connect them in some way I am ordering and unifying them to give them form and meaning. This is, as Lyotard (1984) argues in *The Postmodern Condition* [3] still the quintessential way of representing knowledge.

The text is always only a limited writing strategy. It follows that interpretation must then have no essential meaning. Writing is not a transparent medium through which real worlds are described and analysed. The words that the reader sees cannot serve as markers that convey notions of a world; they cannot be read as isomorphic to their referents. The words in the text must be seen as an endless permutation through which a multiplicity of meanings or discursive events interweave in power-laden contexts, negotiating for expression. As Berman (1988) argues: "Language wherever used is composed of structured signifiers, systematized among themselves by differences or oppositions and linked to signifieds in a way more tenuous than even Saussure realized" (p136).

Writing is to, for and from others. Who those others are for this text is already predetermined to some extent by the institutionalisation of academic disciplinary

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[2]     For Derrida, meaning is not fixed prior to its articulation in language, but is temporary and relative. Derrida makes use of the concept of *différance* to show that meaning can only occur in a specific textual location and in a relation of difference from all other textual locations. For everything affirmed there is an 'other' that contrasts with it which, though ostensibly absent, is in fact contained in it as a deferred meaning. According to Derrida, experience relies on what he names a metaphysics of presence, that is, the conviction that words are only signs of a real substance which is always elsewhere.

[3]     The question of the narrative position with respect to truth and justice has been central to Lyotard's work. In *The Postmodern Condition* Lyotard analyses the change in narrative legitimation structures of the premodern, modern and postmodern epochs. He does not insist on the impossibility of truth claims and of moral judgment, but on the possibility of local and thus plural and multiple processes of verification and justification according to various language games. He advocates a turn to the 'little story' which validates difference, extols the 'unpresentable' and escapes the logic of instrumentality that derives from the metanarratives of progress.

differences. When the reader fixes meaning, he/she does so temporarily with regard to the discipline, negotiating the contingencies of language, rhetoric, power and history. He/she is always privileging particular social interests since he/she simply cannot 'read' the text for information without a commitment to examine one's own position. Because the reader's representation must pass through the pointers of one's discipline the meanings one fixes have implications for existing practices, contesting them, reaffirming them, or leaving them intact.

The problem for the writer is that words are constrained by the instrumentalising parameters of representation, unable to rejoice in their own sovereignty. Meaning will always be political, contextualised within systems and relations of domination and subordination which give society its current form. These forces work through the text in ways that neither the writer nor the reader can fully anticipate or control, so that the text becomes inherently unstable, in flux, constituted by traces of other signs and symbolic statements. Britzman (1997) calls this "the existential limit of representation: both presentation and absence" (p35). There can never be a clear unambiguous statement of anything, including an intention or a meaning. The writer can never be sure how, at any given moment, the text will be interpreted. This suggests that the relationship between you, the reader, and me, the writer, is not only predetermined but overdetermined. Both of us relentlessly re-inscribe the inclusion and exclusion of both the knower and the known from the production of knowledge. It is in this way that knowledge is politically constituted, 'made' by human communicative action that develops historically and is institutionalised politically.

Whose story is this? It is not the authentic voice of the writer nor could it be the voice of her field of inquiry about which she writes. The very notion of the text as true representation is, as I have argued, problematic since it relies on the assumption of self-presence. This of course leaves unoccupied the space where once the writer and her subject of knowledge resided with authoritative persuasion. I want to suggest that in the space vacated by both it becomes possible to frame the meanings of the text differently. This framing is not strictly a frame, but a network of places linked by the movements by which they become places along the way. The text which follows is framed in this way and could be called a piece of educational research in the postmodern. It attempts to exceed the ordinary channels of social scientific access into which we have become attuned. The story it tells is not representative but is constitutive.

It is a fiction. To call it a fiction may cause some alarm. But academic stories are no less fictional than others. My use of the word here is not to do with something opposed to truth. It is to suggest the particularity of cultural and historical truths, the ways they are

systematic and exclusive. It can be called a fiction in this sense of something fashioned. It fashions a specific field of inquiry, fashioning knowledge through the constitutive effects of language. Its production cannot be considered to be politically innocent since it is persistently normed by politics. It is a social fiction, a cultural artefact continually constructed and reconstructed in the complex fields in which the writing and reading I/eye meet.

These are the limits of my power which I needed to share with you. To write the research story turns out to be a mode of activity circumscribed far beyond my own intentions. The insufficiency of my voice and your engagements with my representations undermine any certain basis for belief. But this provisionality and uncertainty does not absolve me from the responsibility of trying to write about it, even if it means revisiting questions about which everything seems to have been said before. If the text that I hope to construct is always mediated by larger social, discursive and theoretical coordinates, then those limitations of which I am aware can be turned upon themselves, to become sites or positions which generate new questions and readings. Ultimately they can become locations better placed to engage in educational criticism and better positioned to play a role in social change.

## CHAPTER ONE:

## Framing a View

### or

## Paradox, Partiality and Promise

> I shall take as my starting-point whatever unities are already given...; but I shall not place myself inside these dubious unities in order to study their internal configurations...I shall make use of them just long enough to ask myself what unities they form...I shall accept the groupings that history suggests only to subject them at once to interrogation. (Foucault, 1972, p26)

No text is able to proceed, with any semblance of clarity, without agreement between the reader and writer about its object of study. The text which signifies the field of the thesis is not exempt from meeting these obligations. This chapter attempts to establish this agreement, however tentative or conditional. Yet beginning in this way is a paradoxical move in that it follows what it presents itself as preceding. This is unavoidable given that one of the functions of this first chapter is to ease interpretation of what is to follow and enable some mutual understanding of the object of study between writer and reader. Its task then is to elaborate what the reader might expect to find in the text, facilitating a general agreement of what is to be done, how it will be carried out, and why it needs to be undertaken. In establishing a frame for the thesis question to be addressed, it simultaneously eliminates certain forms and conceptualisations whose presence is a hindrance to this particular production of knowledge.

How then might I describe the thesis so as to arrive at a general agreement concerning the 'object' and 'field of study'? I begin with the title and its implications. The phrase 'girls in school mathematics' would usually suggest that mathematics education constitutes the field of inquiry (the perspective of and method for the conduct of the inquiry) while gender constitutes the object of study within this field. This evokes notions of research practice representing objects and methods of inquiry within the 'proper realm' of gender research: that set of knowledge truth-claims and narratives that circulate through and are authorised as units of knowledge by mathematics education communities. So vast is this discourse[1], so ubiquitous and definitive its gaze, that the problem that confronts me is the difficulty in saying something useful about this field of intellectual and political endeavour.

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[1]      My use of the word 'discourse' here is not in that sense routinely employed by those in the field of socio-linguistics, but rather derives its meaning from Foucault's conception of discourse as a reference to ways of structuring areas of knowledge and social practice. Ramazanoglu (1993) elaborates: "discourses [are] historically variable ways of specifying knowledge and truth - what is possible to speak of at a given moment. They function (especially scientific discourse) as sets of rules, and the operation of these rules and concepts in programmes which specify what is or is not the case" (p19). I explore Foucault's conceptualisation later, in Chapter three.

These qualifications are necessary because after a period of inflationary rhetoric about the importance of equity in education for girls it is all too easy to declare that there can be nothing more to say about the school girl in mathematics. But I want to confront the challenge. Moreover I want to confront it in a way that modifies the state of play and works towards transforming it. This will entail making an unexpected move. It is a move that looks outside the present scope for ideas and developments: new ideas that might be resourced for reflection and theorising. For Lyotard (1984) it is the making of unexpected moves, the capability of thinking outside of habit, that is sometimes more productive than a reliance on sedimented layers of conventional ideas.

I want to ask some questions about the relation of girls to mathematics. Let me begin by saying that the status of girls within mathematics is implicated in the way in which society has chosen to configure mathematics historically. The various forms which mathematics assumes, and the theoretical pronouncements which it makes, have to be seen as neither inherently liberating nor oppressive. However like all bodies of knowledge, mathematics is premised on a set of claims to truth, caught up in what Foucault calls 'regimes of truth'[2]. To unpack what this means for females studying school mathematics we need to look at, firstly, how formal education came to be a legitimated social practice, and secondly, how mathematics became a crucial element within the school curriculum. In this way it will be possible to see that what comes to count as school mathematics does not pre-exist the development of certain normalising and regulating practices. A full appreciation of this is not possible here but what can be documented is the establishment of school mathematics and its intimate connection with the Enlightenment values of the late eighteenth century.

Educational theory and practice has its modern foundations in the distinct period of historical development that took place during the late eighteenth century. Its self-understandings have been construed from the basic and implicit assumptions of modernity's Enlightenment visionary metanarrative of moral and social progress. This vision of an improvement in the human condition relies on a commitment to the ideals of critical reason, individual freedom, and benevolent change, and it is these ideals which mass liberal education aims to substantiate and realise. Granted, this commitment has been exercised in a number of ways but it has always sustained the Enlightenment vision of democratic societies peopled by emancipated rationally autonomous citizens. Indeed strategic thinking about the role of education is clearly founded on the Enlightenment idea

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[2]    Foucault's links his notion of 'regime of truth' with power and knowledge. In Chapter 3 this idea is developed and suffice it is to say here that, for Foucault, the discipline of mathematics relies on certain techniques which distinguish it from others. What is accepted and made to function as true and authoritative within the discipline is sanctioned by those charged with saying what counts as true.

of human emancipation since education's practical task is to cultivate the capacity of future citizens to think for themselves in order to exercise individual agency, and in order, collectively, to create a form of social life that would satisfy aspirations and needs. The development of human reason suggests, then, a self-motivated and self-directing individual, empowered to transform the social world.

An articulation of these ideas had received a very clear expression in Descartes' demand for the centrality of human reason. For Descartes, an engagement with rational enlightened thought would provide a firmer foundation for truth. This would be more useful than any other concept of human nature, since to think rationally was to think in accordance with universal principles, independent of particular historical or cultural circumstances. Descartes identified a mode of rational argumentation which articulated an essential distinction between mental and physical objects (in which the former is prior), as the sole route to unimpeachable knowledge. The certainty, control and predictability that it proffered promised freedom from ignorance and rendered suspect the experiential, the phenomenal, the narrative and the supernatural as legitimate knowledge bases. In this form of logic he 'uncovered' "the natural order of things, making possible the construction of technologies through which control might be exercised over the development of events" (Smart, 1993, p62).

Descartes was a mathematician and believed that this more objective, rationally ordered and controllable society would evolve from mathematics. In his view mathematics was the hope for the world, the only reliable means for realising the Enlightenment vision. Over the next few centuries this view came to be the view of others, underwriting all forms of social and intellectual life. It became 'naturalised', equated to 'thinking' and hence fundamental to western democratic society. Indeed, democratic social life, in both its structural and processual terms, in all its various forms today, whether this be, for example, the techno-scientific theorised world of material process, or the business world of money circulation and its instrumentality (Rotman, 1993), reveals an *a priori* commitment to mathematics. Concepts drawn directly from mathematical thought as created by Descartes himself, and by Galileo, Newton, and Leibniz among others, are central to the way we map out, frame, create, model and articulate the world around us. Moreover they fold into and are constitutive of the very abstractions we form, providing metaphors, idealisations and perceptions for us to understand the many realities we inhabit.

The logic of rational argumentation was embodied into educational theory and practice with the introduction and consolidation of simultaneous instruction and the modern classroom system. Initial modernist justifications for including mathematics in the formal

school curriculum revolved around the notion that in developing mathematical reasoning in all people, society would be provided with a more secure rational foundation for attaining knowledge and making progressive change. Indeed the faith in and hopes for mathematics relied on a belief in progressive knowledge. Thus school mathematics became an objective historical force guiding the conduct and organisation of social life, with the promise of making the world a better place. This implicit societal commitment underwrites the intellectual endeavours of mathematics educators and legitimises their political and cultural role in providing formal mathematics classes for, in the estimation of Clements and Ellerton (1996), well over one billion people around the world.

Since Descartes' time, as mathematics increasingly came to be viewed as the bearer of Truth and Knowledge, those who spoke in the name of mathematics came to possess a certain power. And it is easy to see how mathematics with its promise of inevitable progress in the task of human betterment became a prestige school subject, enjoying high social status. But not everyone was able to attain Truth. This was because during those earlier times certain legitimating practices of social inequality rested upon the view that some individuals, and not others, could attain truth through school mathematics and could employ the right criteria - reason - in naming that Truth. To understand how these practices operated we need to look at the conditions that contributed to their emergence.

In the early days of democracy, access to the kind of intellectual and liberatory development that mathematics promised was seen as the exclusive preserve of males. It is true that girls do not belong to mathematics in history in the same manner as boys, on account of their 'female nature'. However female nature is a recent invention. Prior to the nineteenth century constitution of 'female' as a biological entity, 'the girl' was not considered a subject with distinct natural, rather than god-given, attributes. It was primarily the work of Darwin (Walkerdine, 1989) which created the female mind and body as a new object of scientific gaze and which led to the development of a doctrine legitimating what was able to count as 'female nature'. From that time it became possible to make 'true' statements about female nature precisely because in the social thought of the time science was considered the paradigm of a democratic public discourse. Science passed for truth, establishing sexual difference not only as a natural fact but also as an ontological basis for social and political differentiation.

Feminists (for example, Scott, 1994, 1996) have in more recent years demonstrated that 'female nature' has been developed in opposition to 'male nature', in accordance with Descartes' formulation of binary pairs. In these categorical oppositions meanings are derived from an internally established contrast rather than from some inherent or pure antithesis. Definitions are interdependent: men and boys are understood as dispassionate

and reasoned, whereas girls and women display emotion and irrationality. As Scott (1996) has argued, invoking nature as the ultimate authority and drawing on 'common sense' arguments about sexual difference it was possible to argue the inferiority of girls. These arguments played out in assertions that women's biological difference from men rendered them unsuitable for the social tasks undertaken by men. In the nineteenth century these ideas prevented girls from the upper classes from doing intellectual work on the grounds that it would damage their reproductive capacities. This notion was directly tied to the desire to produce a nation of 'good' stock and thus contribute to the Enlightenment vision of moral and social progress.

Contemporary scholarly debates about girls and mathematics do not circulate around notions of progeny but nevertheless continue to derive their meanings from within this complex and gendered history of reason and human nature. Clearly, the history of feminist vigilance over the girl is founded on Enlightenment ideals, and the terms, concepts, arguments, and positions of the girl's status are lodged in what are taken as authoritative scientific research and disciplinary bases. It is these definitive understandings of the girl in school mathematics which have developed into a tradition, producing a history of evolution and cumulative progress. Knowledge and liberation were regarded as incremental and interrelated goals of this tradition, since the uncovering of more and still more precise information about girls in mathematics relied on an assumed power; one that would transform the position of girls and would realise the promise of universal equality. Invariably, however, this pluralistic desire for equality could not effectively change established definitions of the girls. This led to a critique of the methods used and the development of new constructions.

The history which was produced is of the *excluded* girl, the *deficient* girl, and more latterly, the girl as *central* to mathematics, a history in which she progressively finds the means, assisted by legislated social practice and policy measures, to confront her initial exclusion, her under-representation, and her poor performance. What it offers is a teleological story of achievements but one projected toward an ever-elusive goal. The problem of the ever-elusive goal has vexed Elizabeth Fennema, widely considered an authority in this field of study. In a paper presented at the International Commission on Mathematics Instruction: Gender and Mathematics Education, in Sweden, she sets forth her version of the field's research interests and the advances which have been made over the past few decades. She also sets out her observations and suggestions about the current state of play. Citing the basic premise of the International Commission on Mathematical Instruction Study Conference on Gender and Mathematics (1993), namely, that there is no physical or intellectual barrier to the participation of women in mathematics, she argues that "in spite of all the work done by many dedicated educators,

mathematicians, and others, the 'problem' still exists in much the same form that it did in 1974" (Fennema, 1993, p13).

A sceptical response would claim that a crisis in girls' mathematics schooling is constructed for particular research purposes and opportunities. But since these same concerns have fuelled public and political debate over the last four decades, presumably they also resonate at some level with the audience to whom they are addressed. This is a matter that demands serious consideration, given that the general public is more familiar now than ever before with the emancipatory educational project, and given that it forms, to some extent, its intuitions about girls in mathematics from the media and from academic persuasion. Both academics and the public alike sense that something is amiss with the girls in mathematics schooling project; a project which for so long enjoyed major research funding and political interest and which now appears to have promised more than it succeeded in delivering. It would appear that the vision of social progress for girls today through mathematics seems misdirected.

Why is this so? It is not that girls' reasoning capacities are deficient or that their natures are in some measure wanting, though admittedly nature is a difficult entity to investigate. It is not a question of an inadequate methodology in the classification and monitoring of the girl and the articulation of interventions said to emancipate her from oppressive gender identity in mathematics. Instead, in my view, the answer lies within the political discourses which have served mathematics education researchers. These are the discourses of individualism, rationality and emancipation (the primary organising principles of democratic citizenship in western society) that defined the girl in ways that individuated difference and took for granted the inevitability of her transcendence. The problem is that gender work remains heavily dependent on its inscription in this wider body of discursive practices which equates individuality with masculinity.

If we go back to women's initial exclusion from mathematics it is apparent that the terms for her exclusion were centred on the body. Differentiating between men's and women's bodies led to efforts to produce an authoritative definition for gender. The definitive account regarded sexual difference as a natural phenomenon and attributed fixed and opposing identities to women and men. Indeed essentialism[3] became its greatest text. By assuming that girls had inherent characteristic and objective identities consistently and predictably different from boys, and that these generate definably female needs and

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[3]      In Chapter 4 I unpack the notion of essentialism as it plays out in and for the girl in mathematics schooling. At that point, drawing on poststructural arguments, I attempt to develop an argument that renders essentialism, as a conceptual strategy, untenable. The point I wish to make in this chapter is that whilst the notion of essence comes down to us as the justification for laws and policies, it is in fact historically and contextually variable and must be read as the *effect* of those laws and policies.

interests, this account attributed a referent to 'girl' implying that sexual difference cannot itself be altered. There are major difficulties with the notion of gender essentialism not the least being that it projects onto men and women capacities and attributes which are culturally variable and historically specific. Another is that it totalises the shared experiences of women as a group into a unitary phenomenon.

When sexual difference was offered as an explanation for girls' exclusion from mathematics, it was used to justify emancipatory endeavours into girls' schooling and provided an occasion around which to mobilise social assets and resources. But it also marked an inconsistency and presented an irresolvable dilemma for feminists. Addressed as it was to demarcating social differentiation, sexual difference both raised and disregarded questions about the process of establishing social parity. Its intractability could be gleaned from feminist debates which centred on the notions of 'equality' or 'difference'. "Are women the same as men? And is this sameness the only basis upon which equality can be claimed? Or are they different, and because or in spite of their difference, entitled to equal treatment?" (Scott, 1996, px).

Mathematics education researchers were initially attracted to the notion of 'equality'. However in making the claim that girls were the same as boys and that sexual difference could not be taken as an indicator of one's ability to engage in rational thinking, their work could not avoid the problem of girls' presumed sexual difference. Working within the terms of social laws and policies about sameness or difference which were bequeathed to them, their work was directed towards establishing 'sameness' as a basis upon which equality could be claimed. The difficulty was that in acting on behalf of girls' interests they had to both accept and refuse existing normative definitions of sexual difference. This played out in their analyses as they invoked both the irrelevance and the relevance of femaleness, and for the identity of all students and the difference of girls. Their explanations served more often to confirm than to challenge prevailing views.

More recently, in order to reconstruct the history of the girl in mathematics, feminist reconstructionists tried to reverse the terms used to discriminate against femaleness. But like other social groups in other historical circumstances, a dilemma arose when, refusing the terms of the girl's constitution as dictated by society, they also had to speak in the very name of the girl that had been constituted for her. Typically experience was invoked to explain sexual difference even as sexual difference rallied forth to explain discrepancies between male and female experience. To that extent their analyses exposed the contradictions and omissions in the definitions of gender that they offered in the name of nature and imposed through policies - contradictions which produced the notion of gender as sexual difference which they had sought to eliminate.

Thus it is this notion of *gender as sexual difference* which has prompted and sustained feminist interventions in the field of formal knowledge, epistemologies and cognitive fields defined by mathematics. But that notion together with its derivative term, femininity, has become a limitation; something of a liability to the way we live now. It cannot engage with the complexity of the issues at stake here and presents a dilemma for the construction of a politics for girls. At the same time the theoretical objections to the project of essentialising and centralising womanhood appear insurmountable. This is a problem for this work since its commitment to a progressive politics of the girl in school mathematics requires a theory which elevates the subjective in constituting her lived reality. It cannot deny selective experience. However, the solution cannot be found in the equality/difference debate precisely because the dichotomous pair equality/difference presents inevitable shortcomings. As Scott (1994) argues:

> If one opts for equality, one is forced to accept the notion that difference is antithetical to it. If one opts for difference, one admits that equality is unattainable...[I]t makes no sense for the feminist movement to let its arguments be forced into preexisting categories and its political disputes to be characterized by a dichotomy we did not invent. (p291)

The equality-versus-difference debate could emerge only within a version of emancipatory politics derived from the Enlightenment project, known as the discourse of liberal-humanism. This discourse, reflecting the characteristic orientation of our Western society, portrays the individual subject as the abstract prototype for the human. In the discursive practices of this politics the individual's very conception requires a relationship of difference. It is the individual - universal and male - who is used as a standard to exclude those who do not possess the requisite traits, among them women and girls. Difference is explained as a function of gender, and femaleness as 'otherness' from a conception of the ahistorical and essential subject. This is a conception of the subject as the source of all knowledge.

Locating equality and difference in this antithetical relationship has a double effect. It refuses to consider the way in which difference has historically participated in notions of equality and it argues for 'sameness' as the only ground on which equality can be claimed. If equality-versus-difference cannot service the structuring of choices for feminist politics, how can notions of sexual difference be recognised? Indeed, how can arguments for equality be made? I want to suggest that the feminist project needs to bring other discourses to bear on the question of girls' relation to mathematics currently entrapped within the logics of exclusion and control. It needs theory that will take the concept of girls in schooling away from designations that simply confirm or reverse hierarchies. Moreover it needs to enable new ways of thinking and acting upon gender. More than anything else the feminist project needs theory capable of grasping the

complexity of people and the cultures they create. It needs to be able to take into account those aspects of social life derived from new social relations, in particular, the information-based economy, the restructuring of work and households, and the altered configurations of gender in a globalised world.

My argument is that gender is more usefully understood as an aspect of social organisation than as a fixed and finite category system. Indeed it would not have been possible for me to question the status of gender as unalterable sexual difference, without first revealing how its hierarchies had been constructed and legitimated over time. What this relativising required was a demonstration of the social interests and investments on behalf of which competing realities worked. It also involved an understanding of how particular material and discursive social structures and processes created the conditions for gender to exist as sexual difference. By examining institutional efforts and the power relations which structured these efforts to impose and monitor a theory of gender it was possible to account for the definitions which this theory has authenticated.

This points towards a study of gender which examines its processes, its multiple causes, and its rhetoric. It seems more fruitful to pose the question of girls in school mathematics within the terms of its local and particular constitution and the strategic position which it holds within the broader social field of relations of power. Viewed in this way, gender becomes the "social organisation of sexual difference" (Scott, 1988, p2). It is an open category, experienced differently across cultures, social groups and time, and playing differently into structures of power. Precisely because gender is implicated in wide-ranging discursive contexts, it establishes meanings for bodily differences. Thus it is gender, and not the body, which determines how sexual difference will be organised socially. It is in this sense that the category gender is not jettisoned but is emancipated from its essentialist bounds in order to assume a politically mobile position.

These intuitions received a clear theoretical elaboration in the social theories of the postmodern, particularly in poststructuralism. It is in these works that I have found new elements of clarification, useful in moving away from an essentialist notion of the gendered subject and towards a framework that enabled me to see existing research stories of the schoolgirl in mathematics as somehow incomplete. In saying this I am not arguing that in these traditional analyses the girl is inadequately theorised, in need of transcendence and supplementation. Nor am I hinting at problems that surround the methodologies that are prescribed for the research procedure. My point instead is to argue that meanings about the schoolgirl in mathematics that are made to signify in research practice are constructed for specific purposes. I make this point on the grounds that

preoccupation with these purposes mystifies what I see as the most interesting aspect about girls in school mathematics.

If received notions of girls in mathematics schooling satisfy particular purposes then my purpose too has to be stated. I believe that there is a story to tell about the girls which is not a story of equality and difference. To date the politics of authority and knowledge which structure gendered relations have received little theoretical and analytic attention in mathematics education other than by Walkerdine (1989). Granted, questions of the politics of pedagogical relations have been addressed but these are pursued primarily by feminists in the field of teacher education which in my view does not permit a rethinking of gendered relations specific to student positions in mathematics. To date, no-one has examined how the New Zealand schoolgirl constructs herself as a gendered student in relation to the categories laid on her, indeed demanded of her in mathematics. As I make this point I am very much aware that school life is lived differently from one time and one historical period and one place to another. Undoubtedly the history of gendered subjectivity in New Zealand traces a different trajectory from that in other Western cultures but those differences lie beyond the scope of this work. My story is a situated account of girls in a coeducational New Zealand school.

Like the traditional analyses this text represents a desire to do and say something serious about girls[4] in school mathematics. This is a desire which I share with others working for the interests of others who are disempowered through other cultural markers such as race, ethnicity and class. This grandiose scheme is too easily expressed and its realisation can only take place within an analysis of the construction, legitimation and normalising of gender hierarchies. My particular concern as a feminist[5] is with gender, and as one working in mathematics education, the interest is in examining how gender as the knowledge about sexual difference is developed and contested and catches up with adolescent girls in school mathematics: How are girls constituted as gendered students in school mathematics and how do they constitute themselves? This is my research question. It pertains to theories beyond the customary since questions of language, meaning and power are subsumed within it.

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4       In light of the preceding discussion it would be naive of me in representing the interests of girls to give universal or specific content to the category 'girl' as though this naming was common to all girls. There are both theoretical and political objections to essentialising girls through the means of identity politics and these objections will be made in the course of this work.

5       Feminism is a politics representing the interests of women and girls. As a theoretical discourse, Lather (1991) notes, feminism works from the premise that gender is the basic organising principle, profoundly shaping and mediating the concrete conditions of everyday life. However we cannot speak of 'a' feminist theory, precisely because feminism takes many distinct forms. What interests me is that form of feminist theorising which shares a common scepticism with postmodernism towards the principles of universality, objectivity and identity embodied in the Enlightenment philosophy.

It is an altogether different expression of this concern which pervades the work. My speaking position differs from other analyses in that it is developed precisely in relation to a particular historical moment which makes possible, gives meaning to, and situates its discourse. In new theoretical accounts of social life this historical moment is called the postmodern. It is more useful for our purposes to interpret postmodernism[6] as making explicit a new *attitude* towards social reality. What is at stake then is that this text can only become fully intelligible by presupposing this new attitude. Emerging from those gaps endemic in the discursive frameworks of existing 'truths' about girls in school mathematics, the work concerns itself with issues that do not lie within the 'proper realm' of the disciplinary field of mathematics education. Its articulation marks new conjunctions between two intellectual areas: mathematics education, and poststructuralism[7]. My efforts at drawing this new transdisciplinary emergence of ideas and methods together with mathematics education are founded on an understanding of the political usefulness of postmodern thinking for mathematics educational research. They do not arise merely by my fascination with new theory but through a felt necessity to interrogate the interests of girls in modern mathematics schooling practices through the opportunities provided in the postmodern.

Foucault raises questions about the epistemological project. It is precisely because he takes up the fundamental questions of how and where knowledge is produced and by whom and of what counts as knowledge, that I want to argue for his poststructural approach[8] as a powerful analytic perspective for the development of a more radical feminist politics for girls in mathematics schooling. Making a case for Foucault's work at first sight could be seen as unpropitious, given that he never presented himself as a

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[6]     Postmodernism might best be considered not so much a concept as a mood or tendency towards the problematic which developed across the disciplinary fields to express the sense that inherited forms of knowledge and representation are currently undergoing some major change. To understand this, we need to consider postmodernism in relation to the project of modernism. Habermas (1985) maintains that modernity was first formulated in the 18th century by the philosophers of the Enlightenment. The project consisted in their efforts to develop objective science, universal morality and law, and autonomous art according to their inner logic. In this way scientific discourse, theories of morality, jurisprudence, and the production and criticism of art came to be institutionalised. The thinking behind this accumulation of specialised culture was that it could be made productive for the enrichment and rational organisation of everyday life. It is this project which the postmodernists claim is now redundant.

[7]     First and foremost, poststructuralism is a theory of and about modernism, as it (modernism) is in the process of becoming redundant. It represents a collective of theoretical positions which contribute to a new way of looking at taken-for-granted belief structures. In Chapter 3 I elaborate what these positions share in common and work towards developing in some detail an account of the specific approach of Foucault.

[8]     In making a case for the usefulness of Foucault's work my suggestion is not towards a wholesale adoption of his proposals. That suggestion would be fraught with difficulty principally because his themes and interests have changed over time, laying themselves open to critique. However there are places in his work which offer promising new directions for mathematics education.

champion of the feminist project. Indeed Butler (1990) has noted his "problematic indifference to sexual difference" (pxii). However I want to make use of aspects of his work, in the sense he would have approved, as a "toolkit" (Foucault, 1980, p145), and argue that his ideas provide an important way of thinking about gender and provide new ways of analysing gender's constructed meaning. What is radically different about his theory and the methodological approach which derives from it is that his work circumvents the logics of exclusion and control, in order to address the issue of truth about the girl in mathematics schooling from within the terms of the *structures* which antedate, create and exceed the girl herself.

Foucault relativises the status of all truth claims. He gives attention to the social construction of knowledge and asks that we examine truth as a historical production to expose truth claims as always provisional, open-ended and relational. He poses questions about the relation between knowledge and power and theorises these in terms of the operations of difference. Given this, we can think of Foucault's work as radically revising the politics of exclusion. To understand what this might mean for this work requires that we now think of exploring *how* the concept of the girl in mathematics schooling was founded and subsequently modified rather than work towards *discovering the truth* about the girl through an analysis of discrimination. But this methodological procedure inevitably raises the issue of the practices in which the meanings of the concept of the girl were constructed, implemented and came to pose as normative social definitions.

It raises the question of politics. Charting the emergence of the notion of gender and scrutinising its hierarchical descriptions through this kind of systematic analysis exposes the conflictual processes of attempts to define and regulate girls in school mathematics. For the feminist researcher in the postmodern this is a particularly appealing perspective since it encourages a scepticism about the reliability of terms that have in the past been taken as self-evident. For once we begin to historicise the designations 'girl' and 'boy', the subtle and powerful effects of their interdependence emerge, rendering their internal stability suspect. The status of these categorical descriptions is challenged and gender becomes the site of insistent contest and resignification. What it means to be a girl in school mathematics comes to be seen not as 'natural' but as defined and regulated in certain practices during a particular historical period.

Subjection must necessarily be taken into account. From this it is possible to see how the story about the schoolgirl is taken out of its traditional semantic field and connected more directly to issues of subjectivity. In this new story human nature as a unit of analysis becomes redundant. I want to suggest that dispensing with the 'natural' girl is necessary

for the development of a radical feminist politics, since we cannot begin to theorise the multiplicity of practices contributing to her subjection until her essential identity is deconstructed. In making this suggestion I am trying to understand how the girl could be both powerful and subordinate in the mathematics classroom. If she is conceived of as the constitution of an ensemble of subject positions, then her identity is always contingent and precarious. We cannot speak of her as a unified, homogeneous entity. But that is not to say that this approach to truth about the girl in school mathematics cannot offer a designation by which she might be named. These designations, though never definitive nor total, do indeed provide some sense of the girl's identity in school mathematics. This is because at any particular historical moment there is in circulation a finite number of discourses and practices which compete for her production and to which she will respond in some degree, with compliance or resistance; dominant in one relation and less powerful in another.

What I see as important is to be able to talk not about equality and difference but about the ordinary girls of the school mathematics classroom, formed at the intersection of competing claims to truth. They are subjects, created out of the complexities of everyday school life, and cannot be dismissed as part of a deficient group, at risk and in need of recovery, remediation, special inquiries and policies. These are the girls who have not been given a prominent place in the crusading rhetoric which circulates in the discipline. I want to give them their due and start by deconstructing the legacy of their collective and universal subjection which tends to undermine emancipatory intentions. In so doing, I hope to try to understand the conditions of their subjectification. I am interested in knowing how their world is shaped by circumstances beyond it and how we might go about changing these conditions. Because I want to suggest how we might neutralise those forces that factor in against the emancipation, growth and development, I need to understand their power struggles and how they become subjects and live their subjectivity in mathematics.

Approaching the girl in school mathematics as a plurality raises the question of how to investigate such a phenomenon. It points to a concrete examination of the mathematics schoolgirl as a historical phenomenon, produced, reproduced, and transformed in different situations and over time. For research in the postmodern, the girl in school mathematics *is* the production of the discourses and practices through which she becomes subjected. These are the practices and discourses that have often either in the past or have currently competed for her production. An examination of the past and present constitutive elements that define her becomes critical. Taking the category 'girl' to be both descriptive and normative I want to unearth the position of individual young women in school mathematics. I want to investigate the relation of teenage girls to school

mathematics by looking at girls' own engagement with it. This involves not a devaluing of their experience but an understanding of the constitution of its position within relations of power.

Such a gesture points to a different kind of analysis not only in the vision it provides but also in the level and style of intervention it advocates. It is an analysis that does not attempt to make its claims to an empirically verifiable real truth. Its truth demands attention to historical specificity and as such, is always provisional, open-ended and relational. With this critical redeployment emerges a different set of strategies, protocols, and conventions for research. The intent is to inscribe limits discursively, epistemically, and strategically, rather than endeavouring to represent what 'is', or to provide the foundations for that which is known as 'common sense'. Such a practice carries with it political consequences and is not entirely separable from considerations that might broadly be called ethical. Moreover, such a politics is a project haunted by crisis. This is of necessity, because it inhabits that shifting space (Irigaray, 1985) between what is and what ought to be. It is this very space of contradictions, and the tensions which arise within it, which dictates the work. Baudrillard (1983) has a useful way of looking at this space. He suggests we view it as an unpredictable network, dispersing, circulating and proliferating the exchange of knowledge. Within it might be seen new lines of discussion for developing a feminist politics. The point is to open up thought for creative constructions of girls in school mathematics for the purpose of bringing about social change.

Chapter 2 provides an historical analysis which allows us to begin to understand how present truths about the girl in school mathematics have been constituted and come to be as they are. My approach is to look at the conditions which produced the various strands of knowledge about girls in school mathematics. By locating disciplinary sites and junctures at which the discourse of girls and mathematics formed and reformed, my aim is to map discourses over a five-decade period. In contrast to revisionist histories, the history of discourses undertaken here outlines how epistemological, sociocultural, political and institutional rules converge in historical configurations, enabling and constraining the production, authorisation, and legitimation of scientific knowledges about the mathematics schoolgirl. A further concern is to uncover the conceptual conditions under which the notions of deficiency and compensation became possible. It sets the stage for establishing what has to be investigated and how to intervene.

The survey gives a broad overview of the field and reveals the ways in which discourses and practices have transformed girls in mathematics into particular subjects. It is traced exclusively from scholarly books and journals from a large volume of studies produced,

to begin with, from the late 1950s to the late 1980s. Inevitably decisions had to be made about inclusion and I have given prominence to what I consider to be significant work. In contrast to this body of work the published output during the 1990s from the reconstructionists is small. The chapter reports on these. As in all historical analyses periodisation presents a dilemma. As much as possible the text proceeds chronologically. However it often seemed more appropriate to thematise the discourse according to research models and interests. I have tried to combine these two approaches, in the hope that the chapter does not give undue representation to any one period or theme.

The review unfolds by establishing the parameters of the academic discourse of girls and mathematics. The intent is to identify what conceptual ideas about the mathematics schoolgirl are in circulation and to establish the discursive field against which subsequent changes in the mathematics-girl relation can be identified. During the late 1960s and early 1970s school mathematics, perhaps more than ever before, engendered public interest for its emancipatory and democratising promise. Academic work was fuelled by this interest and was drawn into ideas associated with 'second wave' feminism. The analyses that resulted revolved around efforts to uncover gender blindness as well as gender biases. In these early years theories were established, research agendas set, problems defined, and founding figures named. This later involved an extensive engagement with gender differences in the processes and outcomes of school mathematics, and an interest in exposing these gender inequalities as matters for mathematics education to address.

More recently feminist work in mathematics education has concerned itself with the task of feminist theoretical reconstruction of mathematics. This work emerged for a growing discontent with the male-centredness of schooling and engaged most directly with the feminist epistemologies that had emerged from within the discipline of science. Feminist reconstructionists pointed to the absence of gender as a category of interest or analysis in most mathematics theory and practice and argued for theory that would be more inclusive of the experiences of girls. Concerning itself with feminist accounts of mathematics schooling their work focuses on women's concrete experiences across cultures, society and history, posing the question of mathematics' fundamental categories, its methodology, and its self-understanding within the parameters of a women's points of view.

The vast amount of data produced during nearly five decades of scientific research on girls and mathematics has been central to her production as in some way deficit, or more latterly, central to, mathematics. The scientific fact of the deficit girl is recirculated and stands unchallenged in virtually every report. Foucault's work suggests that the scientific fact about the girl in school mathematics is a historical creation, contingent on how the

girl is construed in particular discursive representations. From this it is possible to understand how these facts are ultimately linked to theories of the gendered subject, since underlying everything that is said or written about her are certain assumptions. Clearly the research of the 1970s and 1980s did produce truthful accounts of lesser innate ability in mathematics, and this led to interventionary work on behalf on girls. Such accounts, however, built on earlier work, and were predicated on early notions about men and women.

Whilst taking apart the old narratives and looking at their effectivity is important, my project is not solely focused on deconstruction. It also has a constructive aspect in that it provides an 'other' story. The notion of girls' interests raises important issues of identity, agency and community. These issues are central not only to many contemporary accounts within social and cultural theory but more importantly to everyday existence in the mathematics classroom. This work focuses on these concerns and responds to the postmodern imperative to see forms of identity as situationally produced, and as temporary and historical. My point of departure is based upon an effort to break out of the limitations of increasingly inadequate categorical systems and move towards theory which is capable of grasping the complexities of people and the cultures they create. In Chapter 3 I trace the development of Foucault's theoretical reappraisal of knowledge and the subject, steering his inflecting politics towards the project of the girls in schooling.

Foucault is critical of total theories which claim to account for all aspects of human existence. In his exacting scholarship he identified certain knowledges - human sciences - and certain attendant practices characteristic of modernity, as central to the normalisation of social principles and institutions of modern society. These strategies of management define and regulate the subject to be managed in a variety of practices. When these techniques are taken together with the knowledge of those to be managed, they form what he calls a power/knowledge couplet. Foucault's account offers new ways of analysing constructions of meaning and relationships of power. It also provides a more nuanced understanding of subjectivity. It allows us to understand how classification becomes a form of social categorisation through which what it means to be a girl in school mathematics is defined and regulated during a particular historical period in practices. For the girl in school mathematics the specific practices are, for example, those pertaining to formalised school work, to the classroom, to the family, to the media, and so on. These practices, Foucault suggests, are best traced through historical-critical analyses which reveal the making of identities, selves, and social norms.

It is in his later work that I found a perspective for understanding the mechanisms of power and the possibilities of change. Chapter 4 begins by looking at the difficulties that

his earlier work presented in thinking through the question of power and emancipatory possibilities. It proceeds with the argument that Foucault's later works offer a useful theory which reconciles these difficulties. His later ideas allow for a more complex and differentiated analysis of relations between gender and power. This is important for the development of a progressive politics for girl. Theory that is useful and relevant for political practice must provide an understanding of the girl in schooling as an active agent capable of intervening in and transforming her environment. I suggest that Foucault's theory of the self, concerned as it is with the discursive construction of subjectivity, is able to acknowledge the potential of creativity and agency within social constraints.

In Foucault's analytical framework the notion of discourse is a central methodological issue. For me it has been tremendously important because it suggests that the constitution of present truth about girls in school mathematics is intimately connected to discursive practice. In order to understand the truth about girls we need to examine these practices, paying attention to how meanings are made to signify within the practices and how meanings which inscribe subjects are made and made to make sense. To unpack what this means we need to look at the concepts of power and knowledge, of governmentality and at practices of the self. The starting point is no longer with questions of gender difference but with questions of classroom practice. This leads to a consideration of how power and identity are legitimated, negotiated, and contested towards political ends. Only an empirically informed approach can meet this objective. If the girl is caught up with discourses in the classroom what is required is systematic observation of classroom practice.

In Chapter 5, I look at the conditions which contributed to the method through which my research came to be organised. I provide a model of educational method which I believe directly engages the concern for interrogating the notion of subjective experience and meaning. But it does more than this. It also allows for the possibility of change. My argument is that discourse analysis is a useful means for exploring how subjectivity is created in the practices in which people are made subjects. The method makes use of instances of coherent written and spoken languages, and looks at how these texts operate with particular political interests to generate and sustain relations of domination and power. This permits sophisticated analyses of subjectivity and agency from which to develop complex challenges to dominant versions of subjectivity. It has implications for the relation between language and social institutionalised practice and their relation, in turn, with broader social and political structures will enable me to make some theoretical speculations about the girl in school mathematics based on her specific, emergent and conflictual history.

The following four chapters build on the particular historically specific formations of the girl in school mathematics to try to understand the conditions of her current subjectification: how she becomes a subject and lives her subjectivity at both the social and psychic level. I consider the practices through which those designated 'girls in school mathematics' make sense of and live their everyday school lives by examining a range of texts and practices, employing critical discourse analysis to see how the various discursive resources which are made available to girls in these texts are organised and articulated.

The most official and authoritative form of discursive practices is the curriculum policy text. Its text makes explicit a political and social order by constructing versions of the world of girls in school mathematics and the subjectivities demanded of them. Chapter 6 looks at how the girl is fashioned in this text. It unpacks the rules and regulations at work which are drawn upon to construct a version of the girl in school mathematics. This entails a consideration of how this textual document embodies particular forms of gendered difference, constructing and regulating girls and their social relations. I look closely at the New Zealand national curriculum statement on mathematics for the techniques it uses in writing about the girl. Understanding how the text positions, locates, defines, enables, and regulates the girl in school mathematics is important because the subjectivity of girls is implicated in the way that it has chosen to reveal its cultural order.

In every respect theoretical choice has important implications for the production of knowledge. In the ensuing discussion I consider how "Mathematics in the New Zealand Curriculum" has conceptualised its subject and the ways in which these conceptualisations are fundamental to the discursive production of the girl in mathematics. This deconstruction is important because the subject is the basis upon which all discourse is founded. Moreover, I do not think that it is possible to explore the discursive constitution of the girl, with a view to altering her status, without first examining the assumptions underlying national prescriptions. I begin by looking at the conditions which contributed to the textual construction of identity knowledge in the contemporary curriculum discourse of school mathematics. I then look at how the subject is constructed, and the way it plays out in the pedagogical relation. This universal construction is revealed as standing alongside a discourse of difference which competes for the girl's identity, but as collaborating with the formulation of subject formation underpinning the concept of mathematical development.

Clearly the claims to truth about the girl are more widely dispersed than those circulated through the official text. Other apparatuses and mechanisms of schooling seek to govern

her. In the classroom she is caught up within discourse and power relations and it is here that she is constructed by the physical, social and discursive space which presents itself to her. The classroom is an important element of educational analysis since formalised educational practice is centralised within its walls. The communities that develop within it are sites of the expression of justice and identity. I am interested in how classroom practices of subjectification operate for three girls. In this I am not suggesting that these educational practices have the full measure of the girl's subjectivity, but rather that to some extent and in some ways they produce her as a girl in mathematics.

Investigating this requires the kind of close and detailed attention to discourse that focuses on individual students, however idiosyncratic. In one sense, these girls were not unique. Like other girls in their class they were all credited with passing the first major national school mathematics examination. It seemed to me that an in-depth investigation of their ideas and conceptualisations, their dialogue and invective, their irony, and their actions, through the method of discourse analysis, could provide insight into the different political and philosophical issues historically and contemporarily involved in their claims to school mathematics. However, it is not a biographical approach that is undertaken here: I believe personal life experiences do not provide a sufficient explanation for feminist politics. Rather I want to understand these girls in terms of the discursive processes that produce subject positions for them and which make agency possible even when it appears to be withheld.

Looking at everyday practice within the classroom is important precisely because it provides a medium through which we can come to some understanding of how, on a rational level, the girl is constructed and how she, in turn, constructs herself. But if our understandings are going to embody the complicated nature of social life as it is currently lived then we also need to look at the complex realm of psychic life to understand how meanings are made to signify within material circumstances. Chapter 7 represents a theoretical journey into Donna's familial and classroom world at the rational and unconscious levels, a world traversed by competing storylines of gendered experience, and representations of the history of girls in school mathematics which were not of her making. I have tried to convey these contradictory productions of knowledge and identity which competed for Donna's attention by constituting my own narrative in order to reveal how she lives out these contradictions which deny her any suggestion of the essentialism and universality current in the cultural representations and psychoeducational accounts of the girl in school mathematics

The mathematics classroom is over-populated with meanings for the girl prior to her entry through its doors. Chapter 8 looks at how Amanda negotiates the categories imposed on

her within the everyday patterns of classroom life. The concern is with the discursive rendering, the contestation and the transcendence of the meanings of girls as 'nice', 'quiet' and 'good' within the mathematics classroom. These are issues associated with the construction of femininity as a universal category. My exploration shows how Amanda builds and rebuilds her identity with subtle yet powerful means, reconfiguring her position from feminine and hence deficient as perpetuated in the powerful conventional narrative, to one in which she makes obvious advances in her mathematical work. The analysis reveals that behind Amanda's apparent complicity with certain discourses of cultural femininity, lies a strategic attempt to remake gendered meanings. In this strategy subjectivity refuses to stand still, continually remade instead by slippages within the discourse itself.

Subjectivity is continually on the move, never stable and fixed, forever refashioned in relation to powerful discourses and practices. In examining Rachel's mathematical background and her work in the classroom, Chapter 9 acknowledges tensions of knowledge as partial, as interested, and as, more importantly, as inevitably performative of relations of power. The classroom is shown to be a place where norms, beliefs and actions are produced, legitimated, negotiated, and contested. For Rachel, it reveals how her construction necessarily involves accommodations, some form of 'give and take' between herself and others, involving competing forms of knowledge, and clashing investments and desires in certain discursive practices. The engagement shows how Rachel's own interests both constrain and enable her to affirm her own experiences. To some extent the focus is on power, and on how Rachel is caught up in the oxymoron called 'girl in school mathematics', one within which she is ultimately unable to exercise the agency required to challenge the authoritative discourse, nor to take risks when the political interests that inform her contestation are at odds with the dominant discourse.

Productions of the truth of the girl have been historically invested in the academy. How mathematics education conceptualises and shapes the normative female learner is construed within power/knowledge regimes and comes to be embodied, enacted, and exposed across a far-reaching network of social relations and practices. The intent here is to destabilise that truth; to suggest instead that gendered subjectivity has a history. One argument of this text is that, because of its historical formulations, the expression of gendered subjectivity is paradoxical. It is this notion of *paradox* which this text works towards. My point is that gendered subjectivity is an effect of ambiguities, inconsistencies, contradictions within discursive relations and practices; practices which often, contrary to their intent, reproduce gendered forms and social relations. The truth of the girl does not lie in her essentialism. Her truth can only ever be *partial*. To speak of her transformative social change is no longer to take for granted the meanings of 'equality'

and 'difference'. The *promise* lies in the interstices of her subjection. Chapter 10 considers the implications of this understanding for emancipatory work in mathematics education.

## CHAPTER TWO:

## Constructing the Girl

or

## A review and discussion of the academic discourse on girls in mathematics, 1950-1999

> There is a battle 'for truth', or at least 'around truth' - it being understood...that by truth I do not mean 'the ensemble of truths which are to be discovered and accepted', but rather 'the ensemble of rules according to which the true and the false are separated and specific effects of power attached to the true', it being understood also that it's not a matter of a battle 'on behalf' of the truth, but of a battle about the status of truth and the economic and political role it plays. (Foucault,1980, p132)

### Introduction

The history of gender[1] and mathematics, like the broader educational research history, has been written as an instantiation of traditional research models. What follows in this chapter is yet another history. However its orientation is not couched within the traditional logic of the field. It writes against the waves of other more conventional historical trajectories, but this is not to suggest that there is some presumption on my part that it constitutes a better, more exact history. To suggest this would be to commit modernity's mistake and interpret a different way of writing educational history as the latest in a progressive and refined 'state of the art' in a succession of disciplinary truths. To do so would fail to acknowledge the origins and purposes of such other histories, for, as I endeavour to show in the following chapter, no discourse can claim higher status or provide better truths than another, without regard to the issues of economy, of structure, of institutional politics and of temporality.

It is a different concern from traditional or revisionist literature reviews that motivates and is expressed in this account of gender and mathematics: a concern for an alternative method for an alternative purpose of inquiry, in general, and an explanatory evidence of how the girl in school mathematics has been constituted in the published academic discourse, in particular. My intent is to trace and analyse the development of ideas, the rules and relations of the discursive trajectories about the girl in school mathematics as these have been constructed and subsequently mapped in scholarly discourses over a five-decade period. This necessitates locating the disciplinary sites and junctures at which the discourse on gender and mathematics has been formed and reformed. By considering the

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[1]     In the preceding chapter, I suggested that the practice of equating gender with sexual difference has become something of a liability. I proposed that gender is more usefully understood as an aspect of social organisation. However, the word 'gender' is used in the mathematics education literature interchangeably with the word 'sex'. That being the case, in this chapter I use the words 'sex' and 'gender', precisely as they are used in a particular piece of research.

conditions which produced the various strands of knowledge of the girl in school mathematics I hope to demonstrate the inseparability of 'truths' about girls in mathematics from the very conditions of their emergence and their development. I attempt to do this by outlining how epistemological, sociocultural, political and institutional rules converged historically to enable and constrain the production, authorisation, and legitimation of scientific knowledge about girls in school mathematics.

The text proceeds chronologically as far as possible in order that conceptual, theoretical and methodological transformations can be identified. The material was sourced utilising the following criteria and research procedure. I began with the 'ensemble of truths' manifest in books, overviews of the field, handbooks, and articles, rendered as official knowledge (Apple, 1993) of girls in school mathematics. The final intent was not to produce an exhaustive history of all that has been said and written about the way in which girls have been constituted by mathematics education in its published academic discourse. This unfolded during the process as a daunting and inevitably impossible task. Sources, of neccessity, became selective with a particular aim paramount: to map those constitutions that are considered as authoritative in that they are regularly articulated and referenced[2]. My starting point was the recent research of the past decade and from these texts I traced references to the preceding three decades. A computer search of the literature was also conducted to complement the research generated through the citation network. Both these sources - the citation network and the computer database - together with my subsequent reconstruction of them both, must be considered as discourse-specific rule systems upon which I make my claims about girls in school mathematics. That is, these sources which I have selected to legitimate my knowledge claims, can only ever be seen as merely partial. My hope is that in laying bare the construction of knowledge about the girl in school mathematics as it is ritualised and manifested in academic knowledge exchange, we can be better placed to locate these girls as we proceed towards the twenty-first century.

## Within the gaze of the Politics of the Women's Movement

Intensive interest in research and scholarship in the field of gender and mathematics in Western cultures emerged at a particular historical moment of social and political unease. There are two aspects that contribute to this historical moment: the question of scientific leadership and economic security, and the question of women's representation. The question of leadership and security manifests itself in the sense of emergency that

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[2]        For comprehensive bibliographies of easily accessible and published work in the field of gender and mathematics, see, among others, the reviews provided by  Fennema and Leder, 1990; Forgasz, 1994; Joffe and Foxman, 1988; Leder, 1992; and Linn and Hyde, 1989.

pervaded the American public and filtered into New Zealand society, following the launch of Sputnik in 1957. Faithful to Descartes' legacy, mathematics and science education came to be seen as a 'political panacea', a major instrument of economic and social policy for achieving national objectives, regulating contemporary technoscience and commerce (Rotman, 1993). Such investments in school mathematics were reflected in the status it assumed, both within the community and within schools themselves. In New Zealand, as in other Western industrialised societies, qualifications became highly valued and progression and access to further education, employment, and higher status jobs often became dependent upon mathematical success (Pitman, 1989). Moreover, mathematics came to absorb a large proportion of the resources of every Western education system - resources of finance, of teachers, and of time. As Apple (1995) has noted, the importance invested in school mathematics still perpetuates as Western societies confront crises in the nature of work and the structure of employment, economic recessions and technological change.

Concern for scientific leadership and economic security before too long came to be enmeshed in the much wider social and cultural crisis of the late 1960s. This was an era of 'decentred' social experiences, of emergent political groups with increasingly divergent ideas and demands concerning justice, equality, social legislation, of decline in public confidence of the state, of changes in the structure of the economy, the family, and of the declining authority of previously powerful social institutions. It is in this era that renewed feminist politics were made possible and the representation of women became a key issue for feminist cultural politics. Constituted by and in the breakdown of widely shared categories of social meaning and explanation, feminist movements began by probing the gendered nature of housework (Friedan, 1963) and extended the scope of their vigilance to encompass more and more aspects of social and economic life. One of these sites was the school.

Although the relationship of gender to learning had been explored historically and theorised extensively, second wave feminists, as they came to be called, sought to undermine prevailing ideas regarding the possibilities for the education of women. Within a few years feminist interest in gender and schooling, both in New Zealand and further abroad, had left permanent marks on the face of education. In short, education came to be perceived as an object of demand, as a means of employment, as a source of ideas, and as a site of struggle for broader social change. It was in this social milieu that research interest on gender and mathematics developed. Subsequently, between and within existing discourses, a distinct, identifiable field of study, gender and mathematics, emerged, and girls in school mathematics were constituted for the first time as a distinct group for whom separate research questions were to be formulated. This field of inquiry

was founded upon the conjunction of the dominant disciplinary knowledges current at the time, together with established scientific 'truths' about pedagogical subject positionings.

## The Girl as Constructed within the Psycho-social Discourse

Setting out gender research in mathematics in this way, is to see its emergence as in part the product of intense social change in countries that previously had conceived of themselves, and of the teaching and learning of mathematics, in genderless terms. But its story unfolds not only through its entanglement with this unique set of social conditions but also with the theoretical movements of the era and the purposes which they presuppose. What is the distinguishing feature of most of the early gender work is its vision to develop in all students, girls and boys, the universal power of reason: a power which would empower them collectively to create a better form of social life.

Nye (1990) claims that for generations, philosophical and scholarly discussion on what is distinctive about the life of women pointed to the idea that what is true or reasonable for men might not be at all so for women and girls. Proceeding from the premises of biological determinism[3], the position that women's inferior biology was advanced to render her inferior mentally and spiritually (Agonito, 1977). This position had received a very clear expression in New Zealand during the first half of the twentieth century through the publicised work of Sir Truby King, the founder of the Plunket Society for the care and protection of women and children. Further afield, researchers used various (and often spurious) means to locate the origin of differences within the human body. In this respect Leder (1992) notes the work in 1915 of both Morrison and Thomas, and also makes mention of a certain Harvard (USA) physiologist, Dr Edward H. Clarke, in the 1870s who claimed that the learning of algebra was harmful to the development of the reproductive organs.

Much of early reported research in the 1960s was founded on sexual relativism and reflected on the priorities of mathematical life for students and on the 'proper' relations between the status of the knower and his or her sex (Agonito, 1977). An early study reported in the "Journal of Educational Psychology" in 1958 was more concerned about establishing a reasonable mathematical character for girls than it was in entering into any philosophical debate about the criteria of truth. This study by Sommer (1958) made a comparison between women's and men's ability to recall quantitative information from

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[3]    Biological determinists argue that inequities in the social order are the natural and accurate reflections of inherent biological differences. For an interesting discussion of the evolution of biological determinism, see Stephen Jay Gould's historical analysis of the science of differences, "The mismeasure of man" (1981), New York: W.W. Norton.

within a paragraph. The results argued on the one hand for women's lesser capacity for recall. On the other hand, these same women demonstrated comparable ability in recalling *decontextualised* numbers of six or seven digits. In his conclusion, contrary to what his results suggested, Sommer argued that this may be an indication that *many women are unable to retain large numbers (thousands or millions)* (p191). Sommer's study is noted here for it directs attention towards an awareness of the political 'uninnocence' of the history of the discourse on mathematics and girls. His piece of gender research, like many others conducted in the 1950s and 1960s (see for example, Northby, 1958; and Charles & Pritchard, 1959) begins in the understanding of the schoolgirl as mathematically deficient, and constructs knowledge of her around that inferiority.

The production of 'facts' and 'truths' about girls' inferiority in school mathematics was duly established. In 1974, these 'self-evident' truths were to be made problematic when Fennema steered theoretical and methodological practice away from a reliance on biological determinism towards an epistemological stance which viewed mathematical practice in terms of quantifiable, observable behaviours. This new direction was seen to ensure the kind of rigorous analysis required by the gender-mathematics problem and was made possible by a particular set of knowledges about the girl in mathematics. The 1960s and early 1970s had seen the development of an extensive literature, devoted predominantly to examining girls' supposed lesser inherent ability in mathematics (for example, Poffenberger and Norton, 1959; Riffenburgh, 1960; and Stinson and Morrison, 1959). Within this discursive framework research had reported, as Leder, Forgasz and Solar (1996) note, primarily on differences in the learning of mathematics. What Fennema was able to introduce into the field in the mid-1970s was a greater scepticism about prevailing beliefs regarding the nature, extent, foundations and implications of gender differences. However a preoccupation with conflating mathematical ability with the body did not cease abruptly, since, as Longino (1990) has noted, the body continues to be a source of models and metaphors for current everyday thought.

In the 1974 publication of her influential paper *Mathematics Learning and the Sexes: A Review* in the "Journal for Research in Mathematics Education" Fennema not only clearly revealed that most studies conducted after 1960 did not clearly establish the existence of differences between the sexes, but perhaps more importantly, were problematic in the way in which they arrived at their conclusions. These assertions could lay claims to referential status through the original journal in which they was published. Fennema herself became widely cited in the academic discourse following her publication. As such her work counts as part of the authoritative discourse on gender and mathematics, and the orientation which emerged from it is situated within what is commonly known as classic scientific research.

In her reinvestigations Fennema and her research colleagues queried generally accepted answers regarding both the nature and direction of gender differences research. This body of work inspired Wise, Steel, and Macdonald in 1979 to reexamine the conclusion derived from the data collected earlier in 1959 and 1960 in the research known as Project TALENT, a large-scale testing effort designed, with scientific leadership and security in mind, to identify talented high school students. The researchers were able to show that all of the differences attributed to gender in the original analysis disappeared when the number of mathematics courses taken was controlled.

Later in 1990, Hyde, Fennema, and Lamon resurveyed the research on achievement provided by 100 studies which had investigated **quantitative ability** through analysing computational skills, mathematical conceptual understanding, and problem solving. Their meta analysis attempts to unify a set of studies under one conceptual umbrella, aimed at discursive self-definition for work in the field. Drawing upon the standard approaches of positivist research, Hyde, Fennema, and Lamon reported differences between male and female mean scores of standardised tests and their effects across varying contexts. Previously, test data available from the United States, viz., the SAT-ability test, the National Assessment of Educational Progress (NAEP), the Differential Aptitude Test (DAT) national norming groups, and the Preliminary Scholastic Aptitude test-Mathematics (PSAT-M), had all revealed a decline in gender differences in quantitative tasks (Dossey, Mullis, Lindquist, & Chambers, 1988; Feingold, 1988).

The conclusion of Hyde, Fennema, and Lamon (1990) argues that there is a performance difference between the sexes for computational procedures and conceptual understanding. Females up to the age of 15 perform better on computation, and perform equally well as males after that age. Differences in conceptual understanding are insignificant whilst males show a small advantage at problem solving. Males outperform females on applications of mathematics to measurement, sports and science, while females perform better than males on applications to aesthetics, interpersonal relationships, and traditionally female tasks, such as typing and sewing. However they note that where differences do exist they generally emerge within specialist selective groups of students. This makes any generalisation to the whole population highly suspect. They also note that the SAT-ability instrument, contains inherent gender factors, which leads to heterogenous gender differences across test questions (Burton & Lewis, 1988; Chipman, 1988; McCarthy, 1976; Meehan, 1984). Leder, in 1992, also added caution. She argued that differences are dependent on the content, format and cognitive level of the test administered, the student's age and achievement level, and whether the results are drawn from standardised tests or grades.

Quantitative ability was not the only measure under investigation. In their 1974 landmark analysis Maccoby and Jacklin had reported that gender differences existed for verbal ability and spatial ability, in addition to quantitative ability. Spatial ability thus became a valid research focus for the measurement of mathematics performance. The various research programmes of performances on quantitative or spatial tasks which have looked for differences in performance in mathematics rest on a unique set of assumptions which presuppose that sex-linked differences do indeed occur, and that a positive correlation equates to causation. They then look to spatial ability or computational skills or conceptual understanding to support the assumption. Many researchers have found this notion compelling, assuming that there are indeed differences in aptitudes between boys and girls that have innate causes. What this body of work attempts to do is isolate the nature of these differences, targeting spatial and quantitative ability as two distinct dimensions of these differences.

**Spatial ability** studies look at the process of assimilitating spatially presented material through a field of activities spanning such diverse tasks as locating a single figure within a complex figure to mentally rotating an object as rapidly as possible. The justification for measuring spatial visualisation is based on its apparent logical relationship with mathematics. The Fennema-Sherman studies investigated spatial ability over a three-year period in collaboration with Lindsay Tartre (Fennema & Tartre, 1985). Earlier Maccoby & Jacklin (1974), among others, had noticed differences between females and males in spatial skills, particularly spatial visualisation or the ability to visualise movements of geometric figures in the mind. In their conclusions Fennema & Tarte reported a positive correlation of spatial visalisation with mathematics achievement (which they argued does not indicate causation), but argued that not all girls are disadvantaged by inadequate spatial skills.

In the same year that Fennema's and Tartre's work was reported, Linn and Petersen (1985) undertook a meta-analysis of gender differences in spatial ability and concluded that such differences overall no longer continue to be significant. However in a seemingly contradictory finding from their own investigation these researchers found that substantial gender differences do exist for the mental rotation of a figure through space. The study appeared objective in that it is ostensibly detached from political interests. Closer examination revealed that the apparent differences are more to do with speed at performance than with accuracy (Kail, Carter, & Pellegrino, 1979), and, as Lohman (1988) has shown, can be reduced or eliminated by training. Such differences show little consistency between other categories under investigation and a later analysis by Feingold (1988) confirms this finding.

Four years following the partnership with Petersen, Linn joined Hyde (1989) in revisiting the literature on quantitative and on spatial ability. These reviewers couch the relationship between the female student and these achievement constructs within the terms set by their original researchers - the terms of statistical analysis: variance, standard deviations, and the statistic $d$, which they claim to measure the spread between the male and female mean scores. In pursuit of methodological purity, objectivity, and precision, their discourse of statistics replicated the textual format set by the research it sought to review. It continued to remove the object of study - the schoolgirl of the mathematics classroom - from a social context and recast her into a scientific matrix. Its analysis draws the conclusion that gender differences in cognitive and most psycho-social domains are small and hence should be deemphasised.

Bleier (1984) argued that studies which postulate 'innate' differences in mathematical and visuospatial abilities have been methodologically, logically and conceptually unsound and inconclusive. Similarly, in their review of the relevant literature Crockett and Petersen (1984) concluded that sex-linked differences in cognitive abilities cannot be explained by genetic factors, and argued that the composition of the brains of females and males are much more alike than different. They argued that data which attempted to make positive connections between biological factors and sex-related differences in mathematical achievement were "largely inconclusive" (p98), and tended to neglect the role which cultural factors played.

As researchers began to question their assumptions and cast doubt upon the data used to support their claims, other questions began to arise and new research began to take shape. The issue of mathematical differences shifted its focus, and researchers appealed to the documentation in the literature of differential participation rates as a major cause for concern. Concerns about the discrepancy between the number of women and men pursuing mathematics-related careers or accessing high-status futures escalated as researchers found overwhelming support in the wider community in which mathematics is seen to function as a *de facto* intelligence test (Willis, 1995), filtering the employment choices of both women and men (Sells, 1973; Tobias, 1981). The opting out of mathematics courses in high school was seen to impose restrictions on future employment decisions which are difficult to overcome. These future decisions involved both admission to selective colleges and graduate programmes, and admission to specific programmes within universities that require higher mathematics.

Much of the early work in New Zealand in documenting differences in **participation** sought to highlight these differential rates to participation and consider the areas from

which women and girls have been excluded. This continues to be the focus for some researchers in New Zealand who gather statistics to compare the enrolment of females and males in mathematics courses (for example, Blithe, Clark, & Forbes, 1993[4]; Morton et al, 1989, 1991[5]. Purser and Wily, 1990; Reilly, 1993; Reilly et al., 1988). Confronted with the indisputable evidence of women's poor representation in mathematics courses and in workplaces utilising higher mathematics, mathematics education demanded an explanation that did not presuppose women's inherent lesser ability.

The problem of participation vexed many researchers and they perceived it as their task to find the **causes.** The earliest explanation had been to talk in terms of exclusion: if girls had been granted admission to the discipline of mathematics, they too could have been professors, engineers, statisticians. Within the politics of liberal feminism, exclusion was no longer a valid argument. In the analyses spawned by this politics, as Weedon (1987) has argued, non-participation of women in the past and their relative ineffectiveness in the present time was explained away by the claim that women were somehow obstructed by social practices; that men and women were victims of a sex-role socialisation system which prevents all individuals from fulfilling their potential and achieving reward and status. The argument was that girls were disadvantaged in that they were not permitted to develop independence, freedom, confidence in themselves, and competence; indeed, all those affective variables that were deemed to contribute to higher participation levels.

In 1977 Sherman and Fennema explained girls' lack of representation in terms of limited female experiences drawn from a range of roles and assumptions that view women as very different from men. They hypothesised that if girls could be encouraged to participate in advanced mathematics classes in the same numbers as males did, then differences in gender would disappear. In an earlier study looking at the relationship between **attitude and performance,** Fennema and Sherman (1976) had found that controlling for various affective measures eliminated sex-related differences in mathematics achievement. This study introduced a new instrument known as the Fennema-Sherman Mathematics Attitude Scales (1976) for measuring affective variables in mathematics. The study which looked to social-psychology for its research methodology and its explanations was heavily promoted following the formation in 1976

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[4]     Blithe et al (1993) claim: "An examination of gender differences in these papers [New Zealand Bursary examinations] over several years shows a consistent difference in mean performance in favour of boys" (p427).

[5]     In their 1989 study of Bursary results of the previous year Morton et al (1989) concluded that boys achieved better results than girls in the Mathematics with Calculus paper. However on re-examination (Morton et al., 1991) of results of students who had studied only one mathematics paper (Mathematics with Calculus) at Bursary level, and results of dual-mathematics course students (those who studied both Mathematics with Calculus, and Mathematics with Statistics), the differences that were initially attributed to gender could no longer be substantiated.

of the International Group for the Psychology of Mathematics Education (PME). Two highly influential books in particular urged the adoption of this approach: Begle's (1979) *Critical Variables in Mathematics Education* , and the collection of articles on *Research in Mathematics Education* which was edited by Shumway (1980). As Begle argues in his preface:

> I see little hope for any further substantial improvements in mathematics education until we turn mathematics education into an experimental science, until we abandon our reliance on philosophical discussion based on dubious assumptions, and instead follow a carefully constructed pattern of observation and speculation, the pattern so successfully employed by the physical and natural scientists.

By the end of the next decade the scientific method would form a dominant strand in the discourse of gender and mathematics, effectively marginalising research that did not fit the methodological imperative - the imperative of "rendering the phenomena under question measurable, formulating a hypothesis about the behaviour of the quantities to be measured, choosing a random sample, then testing the hypothesis in this sample" (Jungwirth, 1996, p50). Indeed as Fennema and Hart (1994) note, of the articles published on gender and mathematics during 1977-1992 in "The Journal for Research in Mathematics Education" (JRME), most by far made use of empirical-scientific-positivist research approaches. Fennema's work and the research that it spawned, framed by the new more structured, scientifically rigorous format which she and her colleagues had valorised (see Fennema and Carpenter, 1981; Fennema and Sherman, 1977, 1978; Fennema, Wolleat, Pedro, and Becker, 1981; Sherman and Fennema, 1977), and utilising concepts derived from social-psychology to understand the social aspects of the schoolgirl, helped keep the psychological explanation, as advocated by Begle, alive.

The methodological design and procedure of Fennema's work with Sherman set a new standard which future socio-psychologically oriented research would follow, to such an extent that Walberg and Haertel would in 1992 claim the Fennema and Sherman study of 1977 to be the fifth most cited in an educational psychology journal published between 1966 and 1988. Research output proceeded at an unprecedented and accelerated rate, generating a plethora of explanations in the hope of 'getting to the roots' of the complexity of the gender/mathematics learning relationship. The range of explanatory constructs offered effectively put paid to any presupposed unities of research variables. With Fennema's investigations, gender research had developed a strategy that concentrated on one or a small number of variables in order to prove a direct causal relationship between achievement and gender. The advantages readily became apparent: the construction of the girl as having observable empirical social facts enabled researchers to see these facts as 'objectively' separated from their own beliefs and the personal intentions of the girl's world in which she lived.

However it was to this very design and procedure which Leder would, in 1990, level a word of caution. In an overview of the historical directions and current state of mathematics and gender research, Leder articulated her concerns at the large numbers of possible explanations from researchers working from a range of different disciplines and the consequent fragmentation of the field. She cautioned that one needs to be aware of the shortcomings of piecemeal studies and the dangers of over concentration on isolated elements of what should be considered as a social process. Critical of this simplistic conceptualisation and methodological treatment of the problem, Leder (1990) observed:

> The tendency to concentrate on one or perhaps a small set of variables, and to ascribe differences obtained to these variables alone, has at times given rise to unproductive and largely artificial controversies. These appear to be a consequence of the delineation of the issue, rather than genuinely conflicting results. (p14)

As researchers began to reconstruct the history of their field during the mid to late 1970s and the 1980s, the schoolgirl herself became constructed around a discourse of effects and disadvantage, a discourse which was to anticipate political intervention. The methodological approach drew upon concepts from social psychology to explain gender-related differences. In this theorisation the female learner is conceptualised as *an effect of certain factors which serve to influence her relationship to mathematics*. As the tradition developed, the discourse of psycho-sociological research quickly established itself as a very influential approach yielding incontravertible evidence of effects on the schoolgirl in mathematics. And as the tradition developed so too did the explanatory tools: it looked at a host of school variables, teacher variables, to peers, parents and the wider society for its explanations. More and more concepts were utilised, the chief of these, Jungwirth (1996) notes, being **attribution theory, self-concept, role concept, and the concept of attitude.** Moreover, it initiated the development of two models: the **Autonomous Learning Behaviour** (Fennema & Peterson, 1985) and the **Model for Academic Choice** (Eccles et al., 1985).

In their 1975 publication "Sex: Does it make a difference? Sex roles and the modern world", Grambs and Waetjen directed the focus towards the complex social processes shaping the aspirations of females and males in schools and in society. Research responded in the first place by investigating the process of **course selection in high school and university**, examining differences in counselling about mathematics in terms of information and encouragement given to students of both genders by school personnel, parents, and peers (for example, Armstrong, 1985; Brody & Fox, 1980; Franklin & Wong, 1987; Jayaratne, 1983; Stallings, 1985; Wigfield, 1983). Luchins and Luchins in their article "Female mathematicians: A contemporary appraisal", published in "Women and the mathematical mystique" in 1980 claimed the males received greater

encouragement in mathematics and science. Structuring their arguments around notions derived from sociology, they argued that an absence of strong female role models, both in schools and in textbooks, contributes to the perception of mathematics as a male domain. Confronted with these claims and those of others, Fennema conceded in 1984 that "adult differences in mathematics-related careers cannot be totally traced to differences in course taking" (p140) in high school. Her concern was that women's non-participation, however that might be theorised, continued to be detrimental to the welfare of women.

Once social processes were posited as critical to participation rates, the possibility that classroom practice could be a worthwhile explanatory tool emerged. The field broadened to investigate differential treatment within the **classroom** by way of teacher-student interactions and behaviours. It also endeavoured to recast the research data in relation to a set of guiding principles, by establishing a classificatory system of exemplary classroom and teaching behaviours conducive to girls' learning of mathematics. It seems plausible that during early the 1980s the emergent sociological discourse was linked to heightened public awareness of the language and meaning of sociology. In that context, that sociological variables such as 'role model' and 'interactions' should become the analytic grid in which the girl in mathematics would be mapped is hardly surprising.

Lockheed (1984) in "Sex segregation and male preeminence in elementary classrooms", published in *Women and Education: Equity or Equality?* sets out to review the literature on **teacher effects**. From the meta-analysis, Lockheed draws the conclusion that gender equity is facilitated more readily within a small group environment than by teacher-centred whole group learning. One year later, however, based on data derived from teaching practice and mathematics performance of students, Eccles and her colleagues (1985) found no evidence of any significant correlation between student attitudes toward learning mathematics and "teacher-style variable" (p114). This was substantiated in 1988 when Glassman, in a study of cooperative learning in mathematics, writing and reading in third, fourth, and fifth grade classrooms, reported no differences between cooperative classes and traditional classes on achievement, in gender or race relations, or student attitudes. Inevitably, teacher-style effects led to an interest in differential learning preferences. In 1992 Owens, Nolan and McKinnon studied **preferred learning styles** and found that girls preference is towards cooperative learning situations. This, they reported, was a consistent pattern for both New Zealand and Australian girls, as well as for girls from England and America. Earlier, however, Cohen, Lotan, & Catanzarite (1990) had issued a cautionary word against forming hasty conclusions by claiming that status factors into levels of cooperativeness in so far as males dominate discussions. This point is implicitly reinforced up by Slavin (1990), and Easley and Sekita (1991) who have shown that collaborative settings raise self-esteem

and cooperativeness itself. Despite this, Owens (1993) has shown that teachers prefer the competitive learning setting.

It seemed inevitable that before long interest in the social process of teaching style would broaden to encompass **teacher-student** interactions. By the 1990s such interactions and their relationships with student achievement had been widely theorised, studied and documented both in education generally and in mathematics education in particular (for example, Becker, 1981; Brophy, 1985; Eccles & Blumenfeld, 1985; Fennema & Peterson, 1986; Glassman, 1988; Peterson & Fennema, 1985; Stallings, 1985; Walden & Walkerdine, 1985). What researchers were undertaking was in effect a replication of each other's work. They found consistency in their findings: that teachers often interact differently with their male and female students; that girls receive less attention from teachers in mathematics classes, and are asked fewer questions; that a smaller percentage of those questions that are asked demand higher-level thinking; that girls are less likely than boys to receive either praise or criticism for their mathematical work, and what praise is given to girls most often reflects standards of neatness or evidence of hard work (Fennema & Petersen, 1986).

The discourse on girls and school mathematics took an unexpected turn with the publication of Leder's 1990 article "Gender differences in mathematics: An overview". Leder set out to unify previous work on effects in her survey of previous studies investigating teacher-student interactions. Widely considered an authority and a discerning researcher, Leder constructed a continuous series within the discourse by implicitly sanctioning the effects discourse. At the same time however she creates a subtle shift in the discourse by arguing:

> It is important to remember...that schools do not function in a vacuum. They reflect the dominant cultural values and expectations of the society they serve. There is abundant evidence that females and males are not always treated equitably in the wider society outside schools; in fact, differences in treatment of the sexes may well be more pronounced outside than inside the classroom. (1990a, p166)

This caution was instrumental in a significant rupture to the discourse of girls in mathematics by 1993. In her address to the International Commission on Mathematics Instruction Conference: "Gender and Mathematics Education", Fennema reappraises the body of work on effects. Widely considered at the time as the author of authoritative work, Fennema, as Professor in the Department of Curriculum and Instruction at the University of Wisconsin, speaks from an institutional site of discursive authority. Through her arguments, she dissociated the series from the current discourse:

> The data that resulted from the studies do not support the premise that differential teacher treatment of boys and girls causes gender differences in mathematics. This

> conclusion has also been reached by others (Koehler, 1990; Leder, 1982; Eccles
> & Blumenfeld, 1985)...There is still no sufficient evidence to allow us to
> conclude that interacting more or differently with girls and boys is a major
> contributor to the development of gender differences in mathematics. (pp6-7)

Fennema's arguments marked a step toward theoretical and methodological refinement from the beginning of the 1990s. However at the time when the 'effects' studies were being carried out, design and procedure derived from social psychology were creating large-scale moves into research on girls and mathematics, and their dominance in the discourse had become evident by mid-decade. Differential treatment of female and male students by teachers of mathematics had been postulated as affecting the learning of mathematics and it was now suggested that it was also related to attitudes towards learning mathematics. Research sharpened its focus to investigate how girls and boys differ in their **attitudes** towards mathematics and the reasons students give for good/poor performance on mathematical tasks.

As a construct, 'attitude' became a compelling research interest during the 1980s in the United States to the extent that research reports at mathematics education conferences in the United States invariably included reports of such work (for example, Ainley *et al.*, 1994; Biaggio & Pelofski, 1984; Blum-Anderson, 1989; Handel, 1986; Jayaratne, 1987; Johnston, 1995; McConeghy, 1987). What developed from this body of work were two analytic models for examining the connections between mathematics disposition and participation. This is the first appearance in the discourse of a conceptual frame with which to analyse attitudinal effects. Both models drew on three concepts deemed necessary for continuation of mathematical study: confidence, usefulness, and sex-role congruency. As Meyer and Koehler (1990) have noted, the 'confidence' dimension, for instance is categorised according to students' positive attitudes towards their own abilities. Perceiving mathematics as needed for future success is embodied in the category 'usefulness', whilst significant others are worked into the concept of 'sex-role congruency' as necessary for higher level mathematics and overcoming 'unfemininity'.

Eccles and her colleagues (1985) took these three concepts in the general model and developed them to explain the factors involved in student academic choices. This model, known as the **Model for Academic Choice** has often been applied in gender work where it attempts to specify the interaction of psychosocial variables related to gender differences in mathematics. It postulates that attributions of past events are instrumental in the formulation of the individual's self-concept of ability (*confidence*) and perception of task difficulty. *Usefulness* and *sex-role congruency* are also incorporated into the model and parents, teachers and other significant others are seen to play an important role in the formation of individual differences in student attitudes.

In the same year in which Eccles and her colleagues had proposed their Model for Academic Choice and subsequent to their undertaking of a series of investigations to identify classroom behaviours influencing gender differences in learning and election to study mathematics, Fennema and Peterson (1985) proposed the **Autonomous Learning Behaviors** (ALB) model. This model draws on the same three concepts and postulates that autonomous learning behaviours (categorised as choosing high-level tasks, and independence and persistence in working habits) are influenced by societal behaviours (of which teachers and classroom figures as central components), and by personal belief systems (*confidence*, *perceived usefulness,* and *sex-role congruency)*. This conceptual frame found favour among many researchers and throughout the next decade would become a fundamental component for gender investigations (see Forgasz & Leder, 1996).

Jungwirth was later to argue in 1991 that Fennema's and Peterson's explanatory Autonomous Learning Model overlooks crucial aspects in the relationship of the female student with mathematics. What Fennema fails to recognise, she maintained, are the subtle processes in the family, the classroom, peer groups, the workplace and everyday life. In her paper published in the *Educational Studies in Mathematics* Jungwirth claimed that interaction research had significant shortcomings in its conceptualisation of social interaction. She based her argument on two points, firstly that the concept of "differential socialization" is premised on the assumption that girls and boys are treated differently by socialising agents which has the affect of generating different attitudes and behavioural modes. Her second point is that research in this area is founded on an understanding of mathematics education and knowledge which pays homage to the role of the teacher at the expense of student/teacher interaction. Jungwirth argues that

> interaction analysis based in this background can hardly gain insights into the microstructures of interaction in the math classroom, structures that might be particularly relevant to understanding the distanced attitude of women towards mathematics. (1991, p265)

More recently she argued for "conceptualizing the phenomena in certain ways and by identifying **proper** ways to analyse them empirically" (1996, p50, emphasis mine). She proposes an alternative microsociological approach drawn from constructivism, symbolic interactionism and ethnomethodology.

In their study of mathematically able students, Fox, Brody, and Tobin (1985) argued that "boys and girls...are more alike than different with respect to attitudes and interests". (p274). They claimed that mathematically gifted girls have more positive perceptions of the importance of studying mathematics than past generations of gifted girls. In the same

year Eccles *et al* found that attitude was affected more often and more strongly by grade than by gender, and that time in school, coupled with grade history, had a negative effect on attitude toward learning mathematics for students of both genders. This same study investigated **attribution**[6] of success-failure. Boys, it was found, were more likely than girls to report that mathematics is not difficult, rated their own ability higher, claimed to exert less effort, held greater expectations of success, and were more likely to consider mathematics useful. These findings are consistent with other later research (for example, Bornholt & Cooney, 1993; Forgasz, 1992; Fullarton, 1993; Joffe & Foxman, 1986; Kloosterman, 1990; Koehler, 1990; Leder and Forgasz, 1991; Meyer & Koehler, 1990; Shuard, 1986; Young-Loveridge, 1992). According to these researchers it is commonly accepted that females are more likely to attribute success to effort and males to attribute success to ability. This body of work paralleled the search for respective achievement aims of students. Utilising a sociological approach which befitted the research question, Leder (1986) and Walden & Walkerdine (1985) both found that whereas males favour achievement in intellectual expertise and leadership skills, females are more likely to aim for excellence in areas in keeping with the traditional role assigned to them, in areas that require social skills.

In 1990 Meyer and Koehler promoted a conceptual template for considering attributions. Weiner (1974) had earlier created a four-factor attribution model - *ability, effort, task difficulty* and *luck*. These attributions were categorised as internal (ability and effort), and external (task difficulty and luck) or as stable (ability and task difficulty) and unstable (effort and luck). In New Zealand, Nicholls (1980) carried out one of the first key works in education on gender differences in attributions of children, through his review of mazes and puzzles. Leder (1982) reworked the concept of attribution by pairing **fear of the consequences of success** with continued participation in mathematics. In her findings Leder reports on a higher male performance in mathematics, a greater proportion of males intending to proceed to higher mathematics courses, and a greater 'fear of the consequences of success' in both males and females expecting to take a less traditional course. Leder argues that for girls high 'fear of the consequences of success' is more likely to be associated with performing well in a traditional male field and not a type of post hoc rationalization for opting out of serious competition in that field. In much of this work girls typically underrate their success, and do better than they expect, while boys commonly overrate their success and do not achieve as well as expected (Joffe & Foxman, 1986). This discrepancy demonstrates both differences in girls' and boys'

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6       Two instruments have been used consistently to measure causal attributions. Fennema and her colleagues designed the Mathematics Attribution Scale (MAS) in 1979 specifically to measure high school students' perceptions of the causes of their performance in mathematics. In 1984 Fennema and Peterson developed the ALB Math Attribution Scale for younger students, in which the choices students made were intended to be easier than the usual 'strongly agree' to 'strongly disagree' responses.

understandings of sex-appropriate responses and the problems inherent in drawing conclusions from self-reported data.

By the mid 1980s the construction of explanatory models came to be an established focus of inquiry. Girls emerged within this discursive network as a theoretical and methodological construct - a construct which overlooked the problem of contingency as it plays out in the relationship of girls and school mathematics. In the estimation of researchers committed to socio-psychological approaches, exposing the 'real' girl was a desirable, even mandatory function of research practice. Later, Ethington (1992) was to point to the problems and dangers in the pursuit of 'effects'; of the tendency to define *a priori* and thus expect to find performance influences in *one* attitudinal direction. Dismissing 'effects' research for its simplistic conceptualisation and methodological treatment of the problem, Ethington (1992) argues:

> The patterns of influences seen through this [research]...emphasize the complexity of psychological influences on achievement outcomes. Influences are not always direct and readily apparent. (p180).

What can be considered, in retrospect, a classic effects study - in terms of methodology and the research tradition to which it paid homage - was reported in "The Relative Attainment of Girls and Boys in Mathematics in the Primary Years" (Shuard, 1986), published in "Girls into Maths Can Go", edited by Leone Burton. Shuard's report cites authoritative researcher founders and their conclusions regarding quantitative ability and draws on these and on her own findings to develop an explanation for differential success in computation and problem solving. The argument revolves around the practices of early schooling. During this time in school in which the traditional curriculum directs attention to computational competence more than other aspects, the mathematical performance of girls is generally found to be equal to or slightly better than that of boys, particularly in **computation**. Shuard (1986) argues that "the majority of primary teachers [privilege] the skills of computation at which more girls do well" (p34) over other skills, such as problem solving, at which more boys excel. In essence what Shuard proposed was a causal link between success in computational mathematics and early schooling experiences which sanction the learner's effort.

Computational mathematical competence came to be acceptable and indeed necessary to the social fabric after the industrial revolution (Damarin, 1995, p251). In this way it came to be constituted as a low level skill within schools and thus appropriate for lower grade learning. Walkerdine (1989) took lower grade teaching and learning experiences in a new direction to argue on behalf of the idea of relative power. She suggested that early identification with the teacher, and acceptance of the teacher's values, provides girls with

an opportunity to adopt powerful stands within the classroom, to the extent of becoming a "sub-teacher".

> By being like the teacher and sharing her authority, girls can be both feminine and clever. This gives them considerable kudos and helps their attainment In many ways the relations of power and powerlessness, helping and being helped, exist between teachers and children and between children. Some girls will be helped by one set of children and be helpers to another; powerful in one set of relations and powerless in another. (p129)

Walkerdine argued that when the emphasis on computation decreases in higher grades and the ability to reconfigure the accepted rules becomes more important, the performance of girls begins to fall behind that of boys:

> To challenge the rules of mathematics discourse [which is often necessary in solving complex mathematical problems] is to challenge the authority of the teacher...If there are pressures specifically on girls to behave well and responsibly, and to work hard, it may well prove more than they can bear to break rules. (p130)

This conclusion contradicts the findings of others with regard to the teacher's influence in the classroom. For example, earlier in 1985 Eccles and her colleagues had found that most teachers play a passive role in the socialisation processes of their female and male students in relation to mathematics. What Walkerdine had introduced into the field was an approach that was less scientific in its form and one which went some way in acknowledging the revolution in social theory taking place at that time. In that same year Shuard (1986) was to suggest from her own analysis that the hypothesis that the primary mathematics curriculum favours boys was not well supported by this new evidence.

Shuard's analysis paved the way for an investigation by Reyes and Stanic (1988) of how socio-economic status and ethnicity interacts with gender to influence mathematics learning. It also led to intense discussions about **coeducation and single-sex settings** and optimal education for girls. In 1988, in a taxonomy so beloved of the period, Gill offered an overview of the terms of the debate, and produced a full annotated bibliography of international work in the field, the chief of these being USA, Britain, Australia. In her critique Gill concluded: "The situation is much too complex to reduce to a straight comparison between school types" (p13); and that "there may be important differences between schools" (p13). The debate concerning coeducational and single-sex provision continues to be of interest (Byrne 1993; Forgasz, 1995b; Gill, 1992; Leder and Forgasz, 1994; Parker and Rennie, 1994; Smith, 1994).

Several writers claimed that the situation is exacerbated by **social stereotyping of mathematics** as a male domain (for example, Eccles *et al*, 1985: Fennema & Sherman, 1977; Leder, 1986). These writers drew on the sociological concept of 'stereotyping' to explain differential performance and participation rates in higher mathematics courses. This work and others drawing on a sociological perspective marked the beginning of a

subtle shift toward theoretical positions that conceptualised mathematics as a cultural product and girls as embedded within and socialised by a cultural apparatus, of which mathematics was only one, albeit influential, socialising agency. Students and education were recast in the broader context of social systems within cultural structures and the practices of society in general taking into account the economic and social needs for democratic citizenship. Zevenbergen (1993, 1995), for example, draws on the work of French anthropologist Pierre Bourdieu to examine how cultural forms are bound up with systems of 'dispositions' characteristic of different classes, of which the school is one. The emergence of this orientation to gender which shifted away from girls to social practices can be linked partially to what was taking place in the wider educational arena. It tended not to displace empiricist models but developed, during the 1990s, as a distinct interdisciplinary line of inquiry, posing questions previously unarticulated by empirical mathematics educational research.

Thus, by the end of the 1980s numerous constructs had been introduced in an effort to explain patterns of course-taking and occupational choice that divided along gender lines. Researchers had examined the influence of parents on the mathematical achievement of girls and boys, looked at how patterns of achievement varied with age, and examined differences in the classroom interactions of girls and boys (including the effects of competitive and cooperative environments on the achievement of gender groups) as well as noting affective differences, and differences in attribution of success and failure. This extensive body of research and the claims that it makes are widely cited in the academic discourse. As such, it counts as part of the discourse which authorises what can be said about girls and mathematics and through the status which it has enjoyed has become the object of many overviews.

Leder (1992), in her international review of work on gender and mathematics, summarised the field in terms of performance and participation and offered an analysis that constituted explanations by one of two categories: Environmental Variables, and Learner-related Variables. In their chapter devoted to gender and mathematics in an anthology of mathematics education in Australasia published by Mathematics Education Research Group of Australasia (MERGA) specifically during the period 1992-1995, the authors, Barnes and Horne (1996), discuss briefly recent reviews of research (viz., Boyd, 1993; Forgasz, 1994; Leder, 1992; Tyrrell, Brown, Ellis, Fox, Kinley and Reilly, 1994; Yates, 1993; Zevenbergen, 1994) and also make reference to a bibliography produced in 1994 by Purser, Depree and Wily, of relevant research in New Zealand. In 1995 the European journal *Educational Studies in Mathematics* (ESM) published a special issue on mathematics and gender. Investigations from the USA, Australia, the Netherlands and Botswana using traditional approaches were reported. Another three

articles drew on alternative perspectives. Similarly the *International Journal of Educational Research* (volume 21, 1994) published a special issue in which researchers reported on various constructs such as spatial ability, learning styles, confidence, performance, longitudinal differences in problem solving and cross cultural differences. In 1996 Leder, Forgasz and Solar produced a major international review in which they reveal that a broad range of variables factor into the debate.

As a result of this body of research that mapped sex differences, monitored subject and career choices of girls, and proposed numerous explanations in the form of constructs, a great deal of information came to be known about girls and mathematics in the complex matrix of classroom, teachers, peers, and curricula, and the kinds of conditions that tend to promote mathematical achievement. In 1990 Fennema summarised the field's findings in this way:

- Gender differences in mathematics may be decreasing.
- Gender differences in mathematics still exist in:
    Learning of complex mathematics.
    Personal beliefs in mathematics.
    Career choice that involves mathematics.
- Gender differences in mathematics vary:
    By socio-economic status and ethnicity.
    By school.
    By teacher.
- Teachers tend to structure their classroom to favor male learning.
- Interventions can achieve equity in mathematics (pp11-2)

In her more recent overview presented to the International Commission on Mathematics Instruction Conference in 1993, Fennema argued: "Much of what we know about gender and mathematics has been derived from scholarship that has been conducted using a traditional social science research perspective" (p13-14). Such studies, Fennema concedes, "have provided powerful and rich information about gender and mathematics" (p14-15). Later in a special issue of MERJ, published in 1997 by the Mathematics Education Research Group of Australia, devoted to gender and learning settings, Forgasz summarised "research efforts [as] uncover[ing] a range of cognitive, affective, and environmental variables on which females and males differed. Explanatory models were postulated" (p253). She specifies these variables later when she notes that:

> ...gender has been found to interact with societal (e.g., race, ethnicity, class), contextual (e.g., home, school/institution, government, media), affective (e.g., attitudes, beliefs, expectations), and cognitive (e.g., abilities, learning styles) variables to influence mathematics learning outcomes. (p253)

Without a doubt this body of socio-psychologically oriented research had made significant inroads into telling the story of girls in school mathematics, whose very telling

was constructed around a discourse of effects. By the 1980s the descriptions of the 'girl' which circulated attained prescriptive force by accentuating the ways in which girls differ from boys in mathematics while simultaneously bypassing any differences between girls themselves. At the same time, however, few researchers acknowledged the epistemological specificity of their assumptions or the ideological nature of the discursive practices in which they were engaged. But what they were at pains to acknowledge was their perception of differences in the processes and outcomes of schooling as a problem and as an emergent educational policy issue. Research reports and the policy texts it generated began to construct girls as educationally 'disadvantaged' (Willis, 1995), as 'missing out' compared with boys in a wide range of ways (Densem & Leahy, 1992; Forgasz, 1997; Grima and Smith, 1993; New Zealand Ministry of Education, 1993). Discourse markers began to speak of addressing this inequality and the form by which this was addressed was through a discussion of classroom and policy intervention measures.

### Interventionist and emancipatory endeavours

Interventionist work in the field recasts the plethora of data presented by gender studies in relation to a set of strategic projects. These strategic projects articulate and identify with a liberatory praxis aimed at empowering girls to create a better form of educational and hence social life. In the 1980s there was a growing presence of the theme of emancipation from educators troubled by an apparent maldistribution of power between male and female students. But this presence was not merely circulating in the form of academic conversations across the gender divide. It was also giving voice, and situatedness priority, to learners who were disenfranchised and disempowered by their gender. Given this valorisation of difference, the interest was in providing female students with an education that must be adapted if equity is to be attained. This idea has generated a variety of new programmes designed to compensate for the obstacles imposed by past discrimination. Such programmes assume that innate differences in ability are uniformly spread throughout social groups and that compensatory education will eventually lead to an equal distribution of sex groups throughout society.

Many research reports had pointed to the need for providing students with career information in junior and senior high school and the prerequisites for mathematics courses (for example, Armstrong, 1985; Brody & Fox, 1980; Brush, 1985; Eccles *at al*, 1985; Sells, 1980; Stallings, 1985) and providing similar information to parents and other significant adults (Brush, 1985; Fennema, *et al*, 1981; Stallings, 1985). Other studies highlighted the need for female role models (Brody & Fox, 1980; Stallings, 1985), for changing the atmosphere of the classroom so that female students are more at ease

(Armstrong, 1985; Brush, 1985; Burton & Townsend, 1986; Stallings, 1985); for the implementation of single-sex classes (Burton, 1990); or altering the context or content of instruction to make mathematics more 'girl-friendly' (Barnes, 1991, 1993; Burton & Townsend, 1986; Eccles *et al,* 1985; New Zealand Ministry of Education, 1992) and in their use of computers (Higgins, 1995). Still other researchers had recommended that attitudes towards mathematics be an explicit part of the classroom discussions (Burton & Townsend, 1986; Fennema et al, 1981) or that all students be required to take four years of mathematics in high school (Brush, 1985). To this end numerous curricular and pedagogical programmes have been designed and implemented and extensive engagement with policy matters has taken place.

The political agenda of each of these various projects determined the appropriate course of action to be taken and this, in turn, was dependent on the definitions which 'equity' was made to assume. In other words, how one defines equity will determine one's course of action for achieving an equitable mathematics education for students of both genders. In 1990 Elizabeth Fennema in her chapter *Justice, Equity, and Mathematics Education* in the text "Mathematics and Gender" which she coedited with Leder, broke with the conceptual monopoly over singular universal notions of equity. As a means to establish attainment of equity specifically for females and males in mathematics education, she reordered the concept into a three-part delineation, categorised as 'equal opportunity', 'equal treatment', and 'equal outcomes'. Entrenched, at that time, in an ideology of value-free practice, Fennema argued for the goal of equal outcomes as the only formulation that could rectify significant differences between female and males should they exist. The claim rested on the understanding that 'outcomes' measured the degree to which equity had been attained in mathematics education by the difference in "the attainment of important educational outcomes" (Fennema, 1990, p4) for females and males.

Five years later Fennema in her role as coeditor with Secada and Adajian of the text "New Directions for Equity in Mathematics Education" (1995) argued that:

> ...some fundamental notions about equity are becoming more qualitatively textured, more explicitly value-laden, and more linked to notions of fairness than has been the case in the past. If equity as an area of scholarly inquiry is to continue to grow and develop, we reasoned that it needs to take account of, and to become situated in, developments in scholarly methodology and in the critical contemporary issues facing education. Research on equity should anticipate new social questions and new directions in research and policy, rather than lagging behind and then having to play intellectual catch-up; it should question what might come to be; and equity-based inquiry should become an integral part of the agenda from the start. (p2)

In the same text, Apple (1995) claimed that "words such as equity are sliding signifiers" (p335). Secada (1995) takes up the point in his chapter "Social and Cultural Dimensions

of Equity in Mathematics Education" to argue that the "'the equity issue' or 'the equity problem'...have become codes for referring to a wide range of often competing notions" (p149), failing to take into account student diversity or the traditions of the institution of mathematics education. He argues:

> It is not enough to raise an issue of equity or even to provide the beginnings of an answer. Rather, that solution must be elaborated so that it fits into the dominant discourse; that is, solutions must fit mainstream agendas for reform and research. Without that fit, proffered solutions are discarded, issues become unsolvable problems, and they are put aside in order that the original effort may proceed. (p150)

A departure from the paradigmatic conceptualisations of equity considerations for the girl in school mathematics was under way. Since definitions of equity are intimately tangled with notions of how mathematics and the girl is understood, the discourse of the girl in school mathematics, during the later part of 1990 was subjected to a wholesale reinvention of its history and its theoretical orientation (see the text of Rogers and Kaiser, 1995). The shift marked the beginnings of a more critical and self-reflective stance and could be attributed to new understandings of knowledge and knowing and a new awareness of these issues in the lives of the girl of mathematics and in the researcher: an emergent recognition within the sciences of the social of the situatedness of all human knowing. By reconstructing the girl as an active agent whose actions in the social environment were seen as contingent upon the interactions between self and other, the discourse cleared a space for an epistemological challenge.

## The Woman's Standpoint in Mathematics Education

During the early 1990s an historical break became clearly evident to the academic community of mathematics education. In 1993, in a paper prepared for the International Commission on Mathematics Instruction Conference: "Gender and Mathematics Education", Fennema presented her personal observations of the field over the past years of extensive work. Almost twenty years had elapsed since the publication of her seminal paper in the Journal for Research in Mathematics Education in which she challenged previous work. In her 1993 paper the message was conciliatory rather than authorising. She argued that although the research represented so far had "provided powerful and rich information about gender and mathematics" (p14-15), and that "positivist scholarship should continue, particularly in order to continue the documentation of gender differences in participation and achievement in mathematics" (p15), nevertheless "an understanding of gender and mathematics based on studies done from this perspective [are] limited" (p15).

Fennema's address and its subsequent publication in 1995 signified a summary underline to the work to date, and as well would serve as a definitive document upon which the research agenda for the 1970s and 1980s was based. But it did more than this: it articulated the mood of uncertainty developing among feminist workers. In drawing attention to the limitations surrounding the conventional production of knowledge in the field, Fennema spoke on behalf of the unease of others who were beginning to question their research practices and look towards alternative forms and methods. What is of interest is that Fennema's paper, derived as it is from a network of selective academic work in the field, was to make a significant contribution to shaping the organisation and production of gender knowledge. Yet again Fennema's scholarly writing served as the authoritative research basis for much of the future work in the field.

A year before Fennema presented her paper Leder (1992) had argued for a subtle shift towards in-depth small-sample research and in 1996 she reiterated this recommendation. This agenda has been the focus of numerous subsequent studies (for example, Atweh, Bleicher, and Cooper, 1998; Boaler, 1997; Higgins, 1995; Johnston, 1995) and reflects similar moves in the wider educational research arena. In another attempt to reconstitute the discourse Johnston and Dunne (1996), in their chapter "Revealing Assumptions: Problematising Research on Gender and Mathematics and Science Education", in the text "Gender, Science and Mathematics: Shortening the Shadow", coedited by Parker, Rennie and Fraser, adopted a framework drawn from Habermas's three knowledge constitutive interests - technical, practical and emancipatory. These writers recommended that research shift from the practical and technical interests to a focus which addressed the production of these categories in the framing and undertaking of research.

Fennema's hopes for reconstituting the academic discourse on girls in school mathematics lay within two distinct theoretical positions: cognitive science and feminist reconstruction. Her proposal of cognitive science could be constituted as a weaker break in epistemic position. Cognitive science locates knowledge in concrete practices and suggests that the mind is modular, and where local knowledges, skills and agencies are made to function. In her paper she notes that cognitive science research is scarce but makes mention of her own work with Carpenter (1992), and her work with Petersen, Carpenter and Lubinski (1990), and also the work of Weisbeck (1992). In her discussion of feminist perspectives which she defines as "feminist methodologies, feminist science, feminist epistemologies, and feminist empiricism" (p22), Fennema proposes a much more definitive rupture:

> I am coming to believe that females have recognized that mathematics as currently taught and learned, restricts their lives rather than enriches them....I believe that we need to carefully examine how feminist perspectives can add enriched understanding to our knowledge of mathematics education. And, indeed, we should be open to the possibility that we have been so enculturated by the

masculine society we live in that our belief about the neutrality of mathematics
as a discipline may be wrong, or at the very least incomplete. Perhaps we have
been asking the wrong questions as we have studied gender and mathematics.
Could there be a better set of questions, studied from feminist perspectives, that
would help us understand gender issues in mathematics? What would a feminist
mathematics look like? Is there a female way of thinking about mathematics?
Would mathematics education, organized from a feminist perspective, be
different from the mathematics education we currently have? (Fennema, 1993,
p26-7)

During the same year as Fennema's paper was published Burton (1995) in her paper
"Moving Towards a Feminist Epistemology of Mathematics", published in the journal
"Educational Studies in Mathematics", made a strong case for a redefinition of an
epistemology of mathematics. Like those who also work towards revisioning the
discourse of mathematics (for example, Damarin, 1995; Issacson, 1986; Johnston, 1995;
Mura, 1995; Shelley, 1995; Willis, 1995) she regards feminist mathematical knowledge
in contradictory terms to mathematical knowledge's self-understandings. Mathematics
claims to be value-free, objective, dispassionate and apolitical. She questions this claim
by arguing that mathematics is male-centred in both its content and its processes. Seeking
to provide a place and power for the experiences of others beyond a white, middle-class,
male community she argues that research guided by the concerns and interests of these
others appears more plausible than the beliefs they replace. Her proposal is that
'knowing' in mathematics should be person- and culture-related; it should be related to
the aesthetics of thinking which it invokes; it should nurture intuition and insight;
recognise and celebrate different thinking approaches; and it should have global
application. Burton implicitly asks that we focus on differences. Her starting point is that
the universe is not objectively knowable. Rather it is the learner who constructs her
mathematical world. For Burton the interest is for the individual to construct personally
and socially viable theories of the ways in which the world works. The production and
formalisation of the discourse she desires to shape is very much derived from the
authoritative names of feminist scientists and their scholarly texts (for example, Harding,
1986, 1991; Keller, 1985; and Rose & Rose, 1980).


The shift towards a more radical stance could be attributed partially to the ferment
generated by the feminist movement, and in part, to an emergent recognition within the
social science academy of the ways in which human agency significantly shapes data and
knowledge, and thereby fashions conclusions about behaviour. The growth of
scholarship within social theory and research, which developed from this shift provided
mathematics education with an institutional framework and theoretical underpinning for
feminist work. As a result a number of feminist standpoints in which feminist values and
goals within social theory, practice and research are prioritised have been expounded that
are at variance with dominant conceptual schemes. These receive their clearest expression
in the work of Damarin (1995) and Becker (1995). Damarin (1995) has explained girls'

historical place in relation to mathematics by examining the philosophies which underwrite it. Becker (1995) and Boaler (1997, 1998) both have drawn on Chodorow (1978) and Gilligan (1982) to question mathematics' rendering of gender as a variable of consequence. Mura (1995) has raised serious objections to the values, practices and implications of modern science and mathematics, and draws attention to connections and mutual harmony between human bodies and the earth. Though diverse in their theoretical approaches, each calls for a reconstruction of knowledge to one that is liberatory rather than harnessed to the forces of domination and oppression. And what is significant is that each reorders the concept of equity.

This new site is based on a recognition of, and celebration of, women's difference from men. Validating women's experiences necessitated a basic restructuring of theoretical and analytical approaches. Earlier aspirations for 'equality' and 'equity' had to be abandoned on the basis that this earlier conceptualisation assumed an acceptance of male-dominated standards and a conformity to male expectations and requirements. By salvaging the girl from the margins of mathematics to her reconstruction as an active cognising agent whose mathematical experiences were seen as contingent upon her experiences in the social field, Burton's (1995) reconstructionist discourse cleared a space for revisioning institutionalised feminist intervention. In promoting the valorisation of 'difference', the interest is in emancipation through the transformation of an unjust social system into one that is more democratic. However the feminist standpoint position maintains that girls' and boys' characteristic experiences do not provide *equal* grounds for reliable knowledge claims. Rather than advancing a relativist claim of this form at the level of the redefined epistemology or its justificatory strategies, the standpoint approach locates *girls as paramount and central,* and formulates mathematical knowledge around the struggles girls wage against male domination. In this way girls' experiences are said to find a truer (or less false) image of mathematical reality than that available only from the perspective of the experience of males. Only then can girls' and women's authority and power to name and 'master' the world of school mathematics from the prism of gender, give girls a new identity.

In her chapter *Gender and Mathematics from a Feminist Standpoint* in "New Directions for Equity in Mathematics Education" edited by Secada, Fennema and Adajian, Damarin (1995) reworks Burton's redefined epistemology towards the interests of women. Her project involves reclaiming and revaluing all things feminine in a mathematics that provides less distorted reflections on the world around us. The feminist thinking which she draws upon for her reconstruction of mathematics is along the following lines: Mathematicians have been men. The arena of rational thought synonymous with mathematics was founded, amongst others, on the exclusion of what is not male. Women

are outsiders here because their assigned role is always 'the other'. It is not that men are cleverer than women at mathematics. It is that women's experience must be either ignored or distorted to fit the conceptual scheme within which rational thought is bound. Research should begin in questions arising from the perspective of women's activities and this perspective must be an important part of the data on which the evidence for all knowledge claims should be based (Harding, 1986). Damarin uses this theorising to validate the individual girl's experience.

Becker's (1995) reconstruction of the discourse of girls in school mathematics derives from the work of Carol Gilligan (1982) on women's moral development. Writing in Kaiser's and Rogers' text "Equity in Mathematics Education: Influences of Feminism and Culture", Becker titles her chapter "Women's Ways of Knowing in Mathematics". Gilligan had questioned the applicability of Kohlberg's hierarchical moral developmental stages to women and argued instead for two approaches to reasoning, both with unique characteristics. Whereas her notion of *separate* thinking reveals objectivity, reason, logic and appeal to justice, her notion of *connected* thought is characterised by subjectivity, intuition and a desire to maintain relationships. Her studies which contrast these ways of defining and developing morality, are predicated on findings that men in this culture tend to see the world in terms of their separate autonomy, whereas women tend to see the world in terms of connectedness. In other words girls speak in a different voice. Becker rearticulates the claim of Belencky, Clinchy, Goldberger and Tarule (1986), in order to construct the girl of school mathematics as a connected thinker whose ways of knowing are markedly different from boys. She suggests that girls' non-participation and underachievement in mathematics can be explained by their preferred ways of knowing and working. Becker asks that we take care not to valorise one thinker over the other but that we pay due respect to both ways of knowing. Rather than rejecting an analysis based on biological differences, Becker invokes these biological differences between girls and boys to explain gender oppression. In that she claims that girls have their own ethics, their own way of knowing and their own language, she regards these ideas of difference as an important part of all claims to knowledge[7].

## Conclusion

With Becker's work the chapter draws to a close this review of the recent history of the construction of the schoolgirl in mathematics. Through its text I have attempted to trace

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7        In Chapter 7 I discuss this reconstructionist work, labelled as a landmark event in the history of gender studies, in which "recent advances in scholarship regarding the teaching and learning of mathematics are said to have brought new insights which are profoundly influenced by feminist thought and methods of enquiry" (Kaiser & Rogers, 1995, p1). The reappraisal which I offer will consider what I see as larger theoretical implications and methodological problems within the revisionist account.

the production of knowledge about girls in school mathematics over the past five decades. What I have tried to show is how the domain of girls in mathematics schooling has been organised, classified and configured as distinct unities over that particular period of time. However, wishing to dispel any illusion of a single 'truth' about girls in mathematics I have attended to the specificity of how that truth was arrived at, taking into account its historical source, who spoke it, and the intentions or desires with which it is spoken. With this motivation I have endeavoured to attend to the politics of knowledge production of the schoolgirl by examining the methodological rules which have been established and the strategic decision making which delimited what could be spoken or written about her. The task which I set myself was to describe a more-or-less chronological series of research attitudes and practices and to investigate how the 'science' of gender and mathematics that eventuated came to be developed. My specific purpose was to attend to changes in the epistemological constructions of knowledge, and the discourses which circulate to make these possible, which intern and enclose the individual girl.

These received histories of modern gender research that I have outlined are textual histories: accounts of significant statistics, dates, names, and research models. What kinds of knowledges about the girl in school mathematics did they produce? The vast body of data produced during this period of scientific research on girls in school mathematics provided, in turn, a discourse of the girl as excluded from, deficient in, and as central to school mathematics. Each discourse circulated and stood unchallenged until a later discourse superseded it and rendered it redundant in gender discussions. Each could be read as constituting a regime of truth in which 'knowledges' and 'justifications' were produced around the object of study and interest, around the girl of school mathematics.

The discourse on gender and mathematics during the 1950s through to the 1980s constructed a set of scientifically validated truths about the girl in school mathematics as having a core self which was deficient. In this discourse the possibility that she could bring her own experiences to her learning was conceptually excluded. By the early 1990s a challenge was mounted which called into question this theorising, and also questioned the nature of political strategies for enacting feminist goals of social intervention. In the wider educational literature Ellsworth (1992) had noted the inherent contradiction in a feminist viewpoint which strives for reciprocity but maintains the 'inside track' on empowering others. Liberatory forms of feminist discourse had long been at the centre of gender research into, and political debates on, gender and mathematics. It now seemed that the discourse markers of 'empowerment' and 'emancipation' were undermining the very agency of girls in coming to a critical consciousness of their own. In the 1990s this liberating gesture gave way to a more radical standpoint position, or more correctly, a *collective* of positions, as the new discursive site for gender research practices.

These particular narratives taken together can only be generated, told, and read in relation to one another. In a very real sense my method revealed an engagement with particular kinds of political struggles, a field mapping certain kinds of meanings produced for particular purposes within very specific historical, social and political conditions. It could also be said to reveal many exclusions and many closures. It is exclusionary in another sense in that my inevitable lack of access to the social relations and political agendas of the authors of authoritative formalised texts has rendered my account incomplete. Under these conditions the project seemed from the start destined to figure as merely fragmentary. However it is offered, with all its inadequacies and exclusions, as an archaeological history of the girl in school mathematics discourse.

## CHAPTER THREE:

## Unwrapping (theory's) presence
**or**
## Discourse, power and the subject in Foucault's counter history of ideas

> I do not conclude from this that one may say just anything within the order of theory, but, on the contrary, that a demanding, prudent, 'experimental' attitude is neces[s]ary; at every moment, step by step, one must confront what one is thinking and saying with what one is doing, with what one is...but, on the other hand, I have always been concerned with linking together as tightly as possible the historical and theoretical analysis of power relations, institutions, and knowledge, to the movements, critiques, and experiences that call them into question in reality. (Foucault, 1984a, p374)

### Introduction

Research always conveys a commitment to philosophical beliefs. In this chapter my intention is to make my particular allegiances explicit. To a great extent these allegiances are tied to an emerging individual identity in social theory, or subject position - one that abandons what may in retrospect be the narrow scope of the identity 'girl' that has been held as an acceptable *a priori* truth in mathematics education. The concern that I want to address here is the issue raised in the previous chapter: the suggestion that the theoretical tools deployed as part of the truth of the identity 'girl' have little persuasive purchase for this particular piece of research at hand. What motivates and is expressed explicitly throughout this chapter is a reappraisal of the status of those conventional beliefs. Consequent upon this I make a case for certain social theories of the postmodern which pose as a challenge to the very fundamental assumptions underpinning much of the understandings in gender and mathematics education.

My theoretical interests are with the central features and ideas of the French thinker Michel Foucault. At the outset I provide an historical and philosophical background for Foucault's particular form of theorising, by discussing its development from and relationship to the 'postmodern'. I then elaborate a series of themes of his work that have special relevance for this research: discourse and language; power and knowledge and the critique of reason. I trace, at various critical stages of his work, the relationship of each of these themes to Foucault's ideas of the subject with particular regard to possibilities for resistance and intervention. These understandings will be taken as a basis for a reflection upon the ethical, epistemological and political issues that underpin the work at hand. My point here is to pave the way towards a more fruitful response, one deemed to be

sufficiently robust to address an emancipatory project in the face of current social and epistemological challenges.

## Postmodernism

Postmodernism, according to Wicke and Ferguson (1994), is a name of the way we live now, a cultural phenomenon in which any discussion of Foucault needs to be embedded. It requires some introduction and I shall begin by briefly surveying the scope of the concept as it has gained currency within contemporary thought over the last four decades. To attempt to define postmodernism in order to eliminate the confusion surrounding the concept might be regarded as a distinctively 'unpostmodern' endeavour, given that the pre-eminent characteristic of postmodernism is 'confusion' itself. At the very least irrespective of arguments about its meaning and legitimacy it is worthy of our attention as a key term in and discussion of Foucault.

Postmodernism is a code name for a theoretical and representational mood developed over the last thirty years which attempts to address social and political issues. It developed in the space created within Western academia as a result of profound political and social crises of legitimation following two global wars, the rise of Nazism and Stalinism, the end of empires, and the threat of ecological collapse (Brown, 1994). As a critical and self-reflective posture and style postmodernism emerged as a different way of seeing and working, a new and external vantage point for making modernity itself an object for critical reflection and makes its Enlightenment assumptions more transparent and open to question and doubt. In the opinion of Waugh (1992), the earlier thinkers Nietzsche and Heidegger, among others, attempt to address social and political issues though an aestheticised understanding of the world. Although the human sciences often marginalised discussions of postmodern aesthetics, Waugh has noted, "[postmodernism] may be more thoroughly and pervasively aestheticising than any previous body of thought" (p7).

Postmodernism is a reaction against modernism. This begs a response to the prior question of what 'modernism' is taken to mean. Here I want to couch the question in terms of modernism's functions and look at the assumptions upon which both its speculative and its progressivist discourses are theorised. In its speculative discourse modernism holds onto a grand design, with its systematising and tidy partitioning (Carr, 1995). This lends coherence to the advancing of an over-arching explanation of the world, an Archimedian point upon which judgments can be substantiated. A primary tenet of modernism, which begins with the philosopher Rene Descartes (1596-1650) and continues into the twentieth century, is that reality has a fixed character. It has certain

qualities regardless of who is observing it. The task of the thinker is to come up with a procedure for correctly describing the nature of the real. That correct description (or narrative) is said to be privileged. Descriptions that conflict with the privileged narrative are, by definition, incorrect. Within this exercise of description the human being is placed in the centre as an independent, detached observing subject.

In a useful discussion Carr (1995) notes that in its progressivist discourse modernism recognises the possibility of emancipation. It works with a set of assumptions about the relation of increased knowledge and understanding to an enhanced capacity for critical reflection, and of this capacity to make sound judgment. It asserts the centrality of human reason to any concept of human nature and the primacy of rational autonomy as a political and social aim. This universal empowering reason was taken up by the Enlightenment project. To engage in rational enlightened thought was to think in accordance with universal principles of rational justification that are independent of particular historical or cultural circumstances and that exhibit the capacity of all human beings for rational objectivity and truth. The basic metaphor of the Enlightenment - that of 'light' - was intended to convey the message that the progressive development of human reason will illuminate the darkness of ignorance and superstition created by the religious and political institutions of the old despotic social order. Once freed from the restraints of prejudice, dogma, and tradition, humanity could become the autonomous subjects of their own development. Human reason would then become an objective historical force guiding the conduct and organisation of social life and making the world a better place.

Central to postmodernism, as it is appropriated on behalf of various theoretical projects nowadays, is an argument for the decline of Western confidence in the discourses of modernity. Waugh (1992) notes that postmodernism was a key term in the vocabularies of the 1960 literary critics such as Ihab Hassan and Susan Sontag who shared a suspicion of subject-centred reason or philosophies of consciousness and in their scepticism the beginnings of a critique of modernity took place. During the early and mid-1970s the term gained a much wider currency, and other postmodern tendencies began to emerge (Waugh, 1992). The debate, originating in literary criticism, spread to encompass first architecture, then dance, theatre, painting, film and music, and then contemporary culture and society as a whole. By the 1990s postmodernism had, in the words of Waugh, "invented the story of its own genealogy" (p1), recalling earlier thinkers such as Nietzsche and Bataille. At some point in the later 1970s, 'postmodernism' was beginning to enter the full range of human sciences through the more recent theorists. Jacques Derrida, Julia Kristeva, Jean-Francois Lyotard, Michel Foucault among others took it up in France. In 1979 its introduction into the larger theoretical and cultural scene was made explicit with the publication of Jean-Francois Lyotard's *The Postmodern Condition*

(translated into English in 1984). In this work Lyotard argued that the 'grand narratives' of Western history and in particular, enlightened modernity, have broken down, a declaration that had been only made implicit in earlier discussions[1].

By 1980 the term extended itself to the 'scientific' and 'moral' spheres. Subsequently postmodernism became a dominant 'structure of feeling' for many intellectuals and an emergent one at the very least for others. The many 'postmodernisms' which developed across the disciplines all seemed to register a common tendency or mood. This mood expresses the sense that our inherited forms of knowledge and representation are undergoing some fundamental shift. It is made manifest by a pervasive dissatisfaction or loss of faith in the forms of representation, the political and cultural practices, associated with modernity. It notes a sense of the inadequacy, both of Enlightenment theories of knowledge purported to be uncontaminated by situational exigencies, as well as in the principle of the general progress of humanity. Carr (1995) notes that what characterises the postmodern world is a common rhetoric of rebellion against the Enlightenment narrative, a realisation that the values, assumptions and explanations that derive from the Enlightenment project are no longer adequate, nor even desirable, when we try to make theoretical sense of our contemporary social and cultural world. Needless to say postmodernism became a controversial term that elicited highly charged reactions across intellectual disciplines and associated historical and political constituencies. It is contested today precisely because there is so much more at stake than the existence or non-existence of a new artistic style or a 'correct' theoretical line.

According to Carr, postmodernism can be construed in a broad sense as a conjunction of three fields of thought aimed collectively at dismantling the Enlightenment conceptions of description, reason and the rational subject. These fields are postmodernist aesthetics, poststructuralist philosophy and literary theory, and post-Marxist sociologies, and they, in turn, suggests a mutation in artistic practice, an epistemic shift in western thought, and an epochal transition to a new cultural order. They employ strategies to undermine and discredit the philosophical foundations on which modernism was first erected. Carr (1995) has summarised these as follows:

1.     Postmodernists criticise the over-ambitious Enlightenment rational project. They oppose and deny the Enlightenment idea of *reason* on three counts, viz, as

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[1]     The collapse of the Enlightenment's 'grand narrative' was famously proclaimed by Lyotard but was already familiar in the thought of Nietzsche, Wittgenstein, Heidegger and Foucault, among others, who had earlier challenged inherited epistemological positions and hierarchies. Nietzsche had much earlier questioned humanhood, morality and the subject and paved the way for a dissolving of the subject at large. In addition he argued that claims to truth, justice and right are merely a mask for determinate social interests or considerations of power.

universal, *a priori,* and absolutist. In a counter-Enlightenment ploy in place of universality they proffer 'local' determinants of what constitutes rational thought and action; in place of *a priori* necessity, they counterpose fallibility and contingency; and in place of absolutism they insist that rationality is always relative to time and place.

2.     Postmodernists oppose and deny the Enlightenment idea of a disembodied *rational autonomous subject.* The Enlightenment self offers certainty and an apparent access to truth in its essential human nature, predating history and prior to a particular form of social life. As a rejoinder postmodernists offer a 'decentred' self - a self that is an effect of discourse which is open to redefinition and which is constantly in process.

3.     Postmodernists take issue with the Enlightenment separation between the *knowing subject* and an *objective world.* Against modernism's insistence that the subject is the source of self-knowledge and of knowledge of the world, a discoverer, postmodernists maintain that the subject's knowledge of the world is always preinterpreted. Reality is in a constant process of construction and that which is warranted at one time, may be unwarranted at another time. There is no 'view from nowhere', no conceptual space not already implicated in that which it seeks to interpret. There is no stable unchanging world, no realm of objective truths, to which anyone has access.

These strategic practices receive their clearest expression (at least in my view) in the work of the postmodernist thinker, Michel Foucault. The only approach in mathematics education that in any way approximates these ideas is that proposed by Vygotsky (Lerman, 1998). But it is Foucault and not Vygotsky to whom I wish to turn now. Other commentators in recent times have argued that Foucault's work is a paradigmatic example of 'postmodern' thought (for example, Hartsock, 1990; Hekman, 1990; Hoy, 1986). Interesting enough, McNay (1994) claims that Foucault himself never saw his work as running counter to the tradition of Enlightenment thought. My motivation in isolating Foucault's work from others is to clarify his particular position and method in order to show how his analyses might help to illuminate the relationship of girls and mathematics. But I do this at the risk of apparent discreditation of other postmodern thinking, and this has certainly never been my intention. I see Foucault's dismantling and reformulations of the Enlightenment conceptions of reason and the rational subject as providing resources for understanding the questions that inform this work on gender within the institution of mathematics education.

## Foucault and Poststructuralism

> Can those who carry out educational research safely ignore that part of their subject (philosophy) which underlies their own investigation?...For, if we do so we cannot claim to be educationalists but must be content with being...laboratory technicians...If we are merely technicians, we cannot claim to be able to criticize the educational foundations and implications of our own work. This means quite simply that we cannot claim to know what we are doing. (Morris, 1972)

Foucault belongs to a group of French thinkers aspiring to a post-Marxist critical approach whose diverse set of postmodern initiatives in social and philosophical thought has been labelled as 'poststructuralism'[2]. "Poststructuralism is primarily a discourse of and about modernism" (Huyssen, quoted in Smart, 1993, p21) and, as Clifford and Marcus (1986) argue, it is quite legitimate to employ postmodernism broadly to include discussions of poststructuralism in literary theory, philosophy and historical and social analysis. What poststructuralism provides us with is a *theory of modernism as it is in the process of becoming redundant*. According to Foucault, its development could be attributed to Symbolist poetry, experimental writing, and the structuralist turn across a multiplicity of disciplines that followed the pioneering work of Saussure.

> Postmodernism would thus signify a nonsentimental adieu - a farewell without tears - to the traditional metaphysical longing for totality, holism, and presence. Poststructuralism would correspondingly become the epistemological - or better: anti-epistemological - corollary of this epochal cultural transvaluation. (Wolin 1992, p9)

Weedon (1987) notes that poststructuralism as a theoretical position developed in and from Foucault's work and the work, most significantly among others, of Althusser (1971), Derrida (1973, 1976), Kristeva (1981, 1984, 1986), and Lacan (1977). Though the work that informs this constellation of theoretical positions varies in significant respects from one to another, there are some commonalities. Each has been identified as contributing to the 'crisis of representation' evident in epistemological, aesthetic, and cultural contexts. Each analyses the limits and limitations of modernism, its unrealisable ambitions, its unfulfilled guarantees, and the dilemmas that arise with the loss of modernism's progressivist discourse. And what they have each in their own ways been successful in doing is to critically and sensitively "overturn inherited structures of belief and convention" (Wolin, 1992, p8).

This diverse field of theoretical positions share in common certain fundamental assumptions of language, meaning and subjectivity. They take as their founding principle that we are now living through the terminal phase of an age that found its inaugural

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2       Foucault would resist this, and any, categorisation of himself.  Indeed it is said that he proclaimed that he did not know what the terms 'poststructuralism' or 'postmodernism' meant or what problems these terms were meant to address. "None of these descriptions is important by itself; taken together, on the other hand, they mean something. And I must admit that I rather like what they mean" (quoted in Usher & Edwards, 1994, p82). Despite Foucault's own resistance, most texts refer to him as a poststructuralist.

moment in the project of 'enlightened' critique, and that the dissolution of this age is signalled by the elevation of *language*. They see language as fragile and problematic and as constituting social reality rather than reflecting an already given reality. To understand this it is useful to emphasise the role that language and discourse have in shaping subjectivity, social institutions and politics. Such linguistically organised social orders are never fixed or stable, and meanings are always shifting, multivocal and sites of contestation. This argues for the ways in which meaning is constructed within language through a process of differentiation: meaning is not absolute in relation to a referent, but is increasingly "sustained through mechanisms of self-referentiality" (Poster, 1990, p13) and thereby deny us any access to an independent reality. In a critique of the modern ideal of self-fashioning subjectivity, the field erases the transcendental knowing, willing and judging subject of the 'enlightenment' project and presents instead the subject as unbounded and decentred in the social field. In doing so it undermines the notion of identity as a fixed and unified phenomenon.

## A Brief History of Foucault's Counter-History

It must be stated at the outset that my endeavour to simplify and unify Foucault's work is guaranteed to distort it not only because of the fragmentation and incompleteness of his work (Gutting, 1994) but also because of its sheer scope and sophistication (McNay, 1994). Foucault is one of those authors who escapes straightforward categorisation. This is his own request: "Do not ask who I am and do not ask me to remain the same" (Foucault, 1972, p17). Foucault's work is fragmented in the sense that it is a series of responses to particular concerns and each response deploys approaches specific to these concerns. Foucault was never searching for essentials. His work was more of a conceptual *interrogative practice* in which he was able to offer various types of theorisation. This is not to say that Foucault is totally reluctant to construct general theories and methods but their constructions are always ancillary to the strategic requirements of the particular challenge at hand. They are "temporary scaffoldings, erected for a specific purpose" (Gutting, 1994, p16). One commentator has put it this way: "as he moves from one topic to another...his purposes and methods seem to change. So there may not be a single "Foucault" to cope with" (Hoy, 1986, p2). It is in this sense his work is inconsistent, never developing a theory or a method that could be seen as an instrument of intellectual progress. This is not cause for dismissal of his major works, or of the many interviews and discussions with him which have been recorded, since each is circumscribed by the unique specificity which each 'encounter' occasions. It is this specificity that needs to be given consideration when examining the effectiveness of each work.

Foucault's work impressively spans the diverse disciplines of literary theory, history, sociology and philosophy. His interests have traversed across the development of psychology and of clinical medicine, to the birth of the asylum and the modern penal system, and beyond to Ancient Greek and Roman morality. Each work looks at the emergence of institutions and the forms of governance associated with them (Usher and Edwards, 1994) and in each the periodisation remains the same: a relatively benign preclassical period (Middle Ages and Renaissance) is followed by a triumph of reason (the classical era) which is succeeded in turn by a third epoch of the 'disciplinary society' of the modern era, in whose grasp we remain today (Wolin, 1992). But his interests are not solely historical: he has also written extensively on modern literature and has produced a structural analysis of the development of Western thought since the Renaissance (McNay, 1994). These literary and historical studies are in turn, as McNay (1994) points out, informed by philosophical reflection on the nature of rationality, truth, and power, and on what it means to be an individual within the problematic left by the breakdown of the humanistic framework.

Not surprisingly the scope and complexity of Foucault's work has often led to certain difficulties in its critical reception. Conflicting readings of Foucault abound. There are those who consider him to be a brilliant thinker, an intellectual artisan, someone who over the years has constructed a variety of artefacts. There are, simultaneously, those who are more rejecting of his work: historians who dismiss it as being too philosophical, philosophers for its lack of formal rigour and sociologists for its literary or poetic quality (McNay, 1994). But it is Foucault himself who is often his harshest critic, and his self-criticisms have forced him to overcome the limitations of his work by pushing his thought in original and challenging new directions.

Foucault is represented by Gutting (1994) as an 'historian of the present', where 'present' is taken to mean 'modernity'. In the very year before he died Foucault stated that the goal of his work had been to create a history of the different modes by which, in our culture, human beings are made subjects (McNay, 1994). What persists throughout his work is a questioning of the various notions of the self-determining, unified and rational subject at the centre of Western thought since the Enlightenment. Indeed his whole *oeuvre* is oriented to breaking with these taken for granted structures of thought and to creating a space for radically 'other' ways of thinking and being (McNay, 1994). Despite the divergence in his approaches Foucault's fundamental aim remains the same, namely the opening up of a space in which to think 'difference' or 'otherness' through the critique of rationality. As Wolin (1992) agues, in Foucault's view, the greatest problem of our time is the inability to think difference or the Other.

Foucault's quest, then, is a search for the 'other of reason', and he pursues this consistently from one work to another, whether the object of study be madness, punishment, or the order of classification itself. But the unmasking of reason receives its most passionate expression in his study "Madness and Civilization" (1961/1965). In virtually all his subsequent writings this quest manifests itself in a fascination with "deviation and deviants and with everything excessive" (Said, 1983, p5). Seduced by "all those things that stand over and above ideas, description, initiation, or precedent" (Said, 1983, p5) he seeks to achieve an understanding of present contemporary social circumstances by a variety of means. If one could put a name to his strategy of investigation and writing it would be 'reversal', in the sense of problematising the assumptions of the modernist project. This methodological strategy whereby apparently marginal cultural phenomena are interpreted as paradigmatic examples of widespread social tendencies typifies much of his subsequent work.

As his work develops from his earliest work which pays attention to questions of knowledge, right up to his final work on the themes of government and the self, we see quite clear differences in focus and intensity in what Gutting (1994, p6) calls the *topical axis of interpretation*. By this he means the thematic level. There are two themes can be seen to run throughout his entire work. These are the themes of *power* and the *subject* (McNay, 1994) that rise to their crescendos in his proclamation of the death of the subject and in his idea that all knowledge is embedded in relations of power. Indeed these themes receive Foucault's masterly treatment insofar as they relate to an uncovering of the normalising 'micro-physics of power' by means of which we are constituted as 'docile bodies'. Through these concepts Foucault is able to unmask reason as intimately tied to the social organisation of power. He discounts the inevitability of who or where we are by showing the contingency and hence surpassability of what history has given us.

## Main Stages of Foucault's work

1.    *Early work on the cultural construction of madness*

Foucault embraces the 'sovereign enterprise of unreason' with characteristic passion in "Mental Illness and Psychology" (1962) and "Madness and Civilization" (1961). On the surface the works constitute in turn a specific study of the madness in relation to psychological and existential dimensions of the individual experience (in "Mental Illness and Psychology") and at a more general level to the cultural constructions of madness in Western society from the Renaissance to the late nineteenth century (in "Madness and

Civilization"). It is in "Madness and Civilization" that Foucault first employs the classificatory scheme that would give direction to his entire subsequent project of a 'history of the present', and it is in this work that Foucault's 'epistemological signature' (Wolin, 1992), the 'power/knowledge' couplet, first makes its tentative debut. Its use in this work prefigures some of the general theoretical concerns of Foucault's subsequent thought.

"Madness and Civilization" has generated significant critical controversy regarding the question of historical accuracy[3]. My intention is to set this dispute aside and to *look instead at the implications for this current piece of work at hand.* If we clear a space for the very specific nature of this investigation to operate at a more general level, then the arguments it employs can be seen to have relevance for girls in mathematics, precisely because at a very fundamental level, "Madness and Civilization" constitutes an attack on Enlightenment thought and the notion of rationality which underpins it. In Cartesian thought which derives from the Enlightenment project, mathematics is considered the ultimate exemplar of rational thinking. Furthermore, this equitable, universally valid and just rationality is sustained by processes of 'normalisation' which involve the silencing of those who exhibit 'the other of reason'. Those others include women and girls, since, as I have already argued in Chapter 1, rationality has been historically defined in masculine terms.

Foucault's undermining of the fundamental notion of rational thought and its disembodied subject also draws conclusions about power. These concerns with power will become more explicit in his subsequent work. It is important to note that Foucault's underdeveloped theory of power at this stage of his writing cause certain major restrictions on his theorising of subjectivity and raises questions concerning the validity of his critique of Enlightenment rationality. If we look closely at how Foucault views the exclusion of society's discontents we see that it is formulated around certain theoretical ambiguities in his conceptualisation of power relations and the way in which these relations operate within the social realm. Foucault claims that the model of power relations with which he worked at this stage is essentially negative in that power is always expressed in strategies of repression and exclusion, allowing for no distinction between forms of thought and situational practices (McNay, 1994; Wolin, 1992). In short, power is assessed bleakly as always repressive in its effects. To this extent Foucault's attack on the rational subject of Enlightenment thought in "Madness and Civilization" is closed in

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[3]      Erik Midelfort (1980) questions Foucault's historical schema in which the mad are understood to progress from an 'easy wandering life' in the Renaissance, to confinement during the classical period, to a situation of total exclusion in the asylums. He refutes the assumption that the mad were not openly excluded during the Renaissance by showing that confinement of the mad was practised widely in Europe before the seventeenth century.

that it does not allow any alternative space in which to theorise non-hegemonic forms of subjectivity, that is, alternative or oppositional subject positions.

Foucault acknowledges in his reply to the philosopher Jacques Derrida's well-known critique[4] that the limitations of his formulation led to an overstatement of the case against rationality. In 1963 Derrida had queried (and later published in 1978) Foucault's conceptualisation of the status of madness itself. He problematises Foucault's attempt to write a history of madness with the implicit aim of uncovering the 'other of reason', to give voice to madness itself. He questions whether it is possible at all to write a history of madness from within the language of reason and order. Reliance on the 'other of reason' as a primordial experience, he argues, keeps it contained within a hermeneutics of meaning, intentionality and depth. In his critique Derrida claimed that a quest for an origin outside of the discourse of reason remains, in the last analysis, ontotheological (Wolin, 1992). Despite itself madness can never be accorded some essential liberated status with the potential to overthrow reason; it can only ever achieve reinscription.

To be sure Foucault's method may be, as Derrida has convincingly argued, problematic but that does not invalidate his observations of general patterns in the modern treatment of madness. Unsettling though it is, the work does however allow a new view of social thought and practice. In particular it resonates with this work at hand in a critique of Enlightenment thought as merely a social construct. But it does more than this: it attacks the notion of 'the one true self' which the wider modern cultural movement embodies in its introspective turn on a perception of the self. It shows how uncovering the 'truth' of oneself is merely a construction, a normalising process that equates inward depths of being with personal responsibility. It is this line of attack, the impossibility of being one's own subject or origin, that Foucault develops to a more theoretically adequate level in his later works and one which I am keen to pursue. I intend to draw on this idea to show that the girl in school mathematics can never aspire to her 'true self', because no such self ever exists. Alongside those observations, I examine the place of various 'texts' of school mathematics in the making of her gendered subjectivity.

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4        Derrida (1978b) argues that Foucault's is an impossible undertaking. He claims that to attempt to write a history of madness from within the language of reason and order even as he locates his work outside of its rationality, is for Foucault the maddest aspect of his project. Derrida points out that the very act of writing constitutes the 'juridical imposition' of order and rationality upon the realm of madness. In this sense then Foucault's history of madness merely takes another form of the excluding and objectifying process which he is at pains to attack.

2.    *Foucault's archaeological phase*

The technique of 'archaeology' is used retrospectively to describe Foucault's attempts to move beyond his earliest work and give meaning to his historical material. His particular interest then turned to coming to grips with the historical and philosophical problem of how ideas change and transform. His work takes as its starting point a rejection of the phenomenological idea that social facts are constructed primarily in consciousness. That is to say that he moves his interests away from the analysis of hidden, ontological sources of meaning in the earliest period of his writing, the hope of locating an original, pure experience, to the development of a method that lays waste to the notion of an atemporal, universally valid form of rationality.

Foucault develops his archaeological method explicitly in "The Order of Things" (1970) and in "The Archaeology of Knowledge" (1972). In both these works Foucault represents a history of order and identity that are imposed on things - a history of the 'same'. "The Order of Things" is concerned with the question of how the being of language has varied over time, and the answer is provided by describing the diverse ways that language has both existed in and referred to the world. In "The Archaeology of Knowledge", written shortly afterwards, languages are seen to be historical in the sense that the structure of thought of different periods arises from different sets of linguistics systems. In both works Foucault focuses on how disciplinary knowledges are made to function. He shows that the historicity of the concepts and objects which have to do with thought, knowledge and power, is at one and the same time unique, specific and general.

Foucault's archaeological analysis reveals that the notion of a subject who exists prior to language, and is the origin of all meaning, is a *fiction* generated by the structural rules that govern discursive formations which govern all thought and speech. What this means for the girl in school mathematics is that she *is* the production of practices through which she is subjected. In the Foucauldian approach, knowledge is not constituted by the girl; instead he regards knowledge as an *effect* of a primarily linguistic discursive formation, ie, a set of fundamental rules that define the discursive space in which the girl exist. Foucault proposes that there are quasi-structuralist rules of formation in all human sciences, which, unknown to the actors (girls) involved, regulate, and determine the spectrum of speech acts which can be taken seriously at any given historical moment. By laying bare these deepseated rules that constitute the condition of possibility of thought, Foucault undermines not only the notion of an originary girl but also associated notions of truth and progress.

Without a doubt Foucault's discussion of the limits of the legitimacy of knowledge relies on his demonstration that all systems of knowledge are in fact statements or discursive events. In turn 'knowledge' receives its clearest expression from the concepts that he proposes pertain to it. It is by exposing the fragility of these concepts - in particular 'discourse' - that he is able to anticipate rationality's eventual demise. But what exactly is Foucault suggesting in "The Archaeology of Knowledge" when he writes of 'discourse'? Earlier in "The Order of Things" he attempts to trace the complex folds and primacy of what could be entertained conceptually as 'discourses' in the determination of experience. But here he failed to specify what he in fact understood by the term 'discourse'. His theorising of the concept was put aside until "The Archaeology of Knowledge".

## Discourse

> They say that there is no reality before it has been given shape by words, rules, regulations. (Monique Wittig, quoted in Pfohl, 1992)

Foucault's use of the word 'discourse' needs to be clarified here because there are many conflicting and overlapping definitions from various theoretical and disciplinary standpoints. He uses the concept of 'discourse' to refer to different ways of structuring areas of knowledge and social practice. It would be productive at this point to look at the conditions which initiated the development of his indispensable critical methodological tools. At this time Foucault had become increasingly dissatisfied with what formal linguistics had to offer language. He considered the attempts of formal linguistic methods to find general underlying rules of linguistic or communicative function working through texts to be too narrow for his needs. He has specifically differentiated his conception of discourse from that of logical analyses, routinely employed by socio-linguistics and by sociology among others, in order to accommodate his intent of providing a counter-reading of historical and social conditions (McNay, 1994).

In the formal methods discourse is taken to mean human conversation. Here the ultimate concern of discourse is with the commonsense knowledges, forms of representation, which inform conversational rules and procedures. Such a narrow focus can only be superficial in its consideration of the ways and means by which concepts and meanings are spoken or written. With this restricted emphasis, knowledge refers to technical knowledge whereas in Foucault's work, as McHoul and Grace (1993) argue, knowledge is understood to be more an issue of the social, historical and political conditions under which writing, speaking and thinking come to count as true or false. In this conceptual manoeuvring Foucault redirects the concept of 'discourse' away from being simply a technical linguistic or interactional accomplishment on the part of self-determining autonomous subjects. It is a move away from structuralism's approach and its opposition to those inherited habits of thought and analysis.

Structuralism had its beginnings in the work of de Saussure (1958) as an approach to language. It makes the claim that language is a system of signs whose meaning and order do not derive from social life or the creative intentions of individual speakers. Rather the meaning and the order of language obtain from the relations of signs to other elements in the system. Each system is marked by an inherent logic which relates the elements to one another, and the task of structural linguistics is to unfold this logic. This basic approach was broadened to become a theory of society. Levi-Strauss is the most important thinker in this regard. By paying close attention to the inner logic which ordered the various elements within each system, he analysed kinship, ceremonies, myths, cooking, marriage, and totems. He maintained that conscious agents do not create the system of meaning in which they live: rather as social subjects they are created by this system and live within it.

Granted, de Saussure's (1958) structuralist analysis of signs was one of the first to break the isomorphism between the real and the representation. By fashioning signs as a separation rather than a dependence, it became possible to imagine signs differently. The meaning of a sign could then be determined not merely by its correspondence to a real thing, but as constituted through its *difference* from other signs and other meanings. These different relations introduced a logic of difference that is the 'other side' of the logic of identity, the latter of which is ordered around a set of assumptions that take as fundamental the relationship between the sign and its referent. De Saussure argued that a sign is not itself through valorisation of its distinctive qualities nor by the virtue of its positive characteristics, but it is always becoming itself through its relations with other signs and its distinctive differences from that which it is not.

By unmasking the historical and contingent nature of all linguistic expression, Foucault renounces the logic of signification of the various discursive regimes, the necessary relations between 'word' and 'thing' that they seek to establish. In his conceptualisation of discourse he posited a more fruitful way of formulating the questions about knowledge that he was keen to explore. For Foucault the term discourse quite clearly refers not simply to language or social interaction but to relatively well-bounded areas of social knowledge. Discourses do not merely reflect or represent social entities and relations; they actively construct or 'constitute' them. Different discourses constitute key entities (be they 'mental illness', 'citizenship' or 'numeracy') in different ways and position people in different ways as social subjects (for example, 'teacher', 'student'). Discourses are more than ways of giving meaning to the world; they imply forms of social organisation and social practices which structure institutions and constitute individuals as

thinking, feeling and acting subjects. Historically specific discourses are discontinuous in that they are distinct from each other at any given time, or at differing times.

By thinking of discourse in this way we are able to consider the historically specific relationship between bodies of knowledge and forms of social control and possibility. In this space it is the level of 'the statement' that is of primary interest, and the questions which are asked of it are 'what is able to be said?' and 'what is able to be thought?' Since statements can only be understood through the medium of the rules which govern their functioning and status, Foucault's archaeological method takes the investigation to its obvious conclusion by looking at the forms. of 'governance' that circumscribe these discourses, or units of knowledge. What is under investigation in discourse are 'rules' and 'processes'. But these rules are not grammatical, but are the rules that decide what is possible to know; those rules which constrain and enable, specifically, writing, speaking and thinking within given historical limits. This *a priori* set of rules of formation that enables certain objects and themes to be entertained at one time and constrained at another time is captured in the term *episteme*. It is "anterior to words, perceptions, and gestures...in every culture, between the use of what one might call the ordering codes and reflections upon order itself, there is the pure experience of order and its mode of being" (Foucault, 1970, pxxi). In light of this project these rules can never be of assistance in the search for a general theory of language.

**The Subject**

Through the method of searching for the various paradigms or structures of representation that had constituted 'knowledge' and 'truth' down through the history of post-Renaissance thought, Foucault is able to initiate a powerful attack on the subjectivism of phenomenological and biographical approaches to intellectual history (McNay, 1994; Wolin, 1992). In "The Order of Things" (1970) Foucault provides an historical critique of the modern concept of man, maintaining that all social scientific knowledge is based on a particular conception of human reality, the conception of *man* defined as that entity for which representations of objects exist. He traces a shift in the mode of being between the knowing subject and the object of knowledge and suggests that the modern mind places its objects of reflection into autonomous spaces that seemed separate from the subject who envisioned them. The objects of the world are ordered as *positivities* that could be classified and interpreted. The events and facts of the world could then be understood as having *great hidden forces* that had *an origin, causality, and history* (Foucault, 1970, p250).

It is the conception of the sovereign subject as the source of all knowledge that Foucault claims has no regard of the fact that the subject itself - its situation, its function, its perceptive capacities - is in fact determined by regularities that are beyond the reach of a transcendental consciousness. This is the same subject theorised in the liberal feminist interventionist project in mathematics education. That subject's theorisation relies on assumptions and beliefs drawn from liberal humanist thinking[5]. Located within this frame the rational free subject's experience is neither sought nor valued, even as her performance and attitudes are measured and monitored. It is neither sought nor valued because liberal humanist thinking relies on a view of the world in which subjectivity is sovereign, the source rather than the effect of language, and furthermore, upon an absolute division between the individual as speaking subject and the external reality of the world.

This is a division that has its roots in ancient Greek philosophy. In an interesting exposition Nye (1990) argues that it was established in response to the problem of how to pin down one's knowing. Nye develops her argument by claiming that the internal logic of knowing insists that existence is an *entity*, which by its own definition must privilege and favour experiences of distinctiveness, singularity, unity and continuity. The emergent problem, attributed to the Greek philosopher Zeno, then is: how can 'movement' be accounted for? For Zeno this is articulated in a paradox: a subject cannot occupy a given space and be moving at the same time. This is the very same logic working through mathematics educational traditional gender analyses. In these works the structuring logic valorises 'being' over 'change', assigning separate ontological status to the subject which moves and the process of moving: they are either the one or the other. As I see it, it is this focus on the realm of 'being' that constrains the possibilities of these critiques. The tendency to draw on these ideas of the subject effectively closes off any discussion of always-already existing social structures and continually changing investments in and attraction of discourses.

Foucault's starting point is that subjectivities are produced within discourse. The meanings that people produce are the result of political struggles involving personal, psychic and emotional investment on their part, and have the capacity to both reproduce these subjectivities and to modify them. This is not to deny that an understanding of the student finds its expression in the lived experiences and everyday school life. But this is a

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5       Liberal humanist thinking is drawn from two world-views of some form of humanism and the more recent philosophy of liberalism. Humanism is characterised by the belief in an essential human nature and in the power of reason to bring about human progress. Liberalism is characterised by a belief in the inalienable right of the individual girl to realise herself to the full. As a conjoint, liberal humanist thinking has given rise to a powerful theory in which social practice plays a privileged role in the development of the individual.

truncated vision of reality. The language that students use cannot reflect experience; it merely offers students a range of ways of interpreting their school life which imply different versions of experience. Students' accounts are not reflections of their mental mirror of their world. It is not that their accounts are fallacious, but that a theory of meaning is more complex than representational, and accordingly it needs to incorporate personal history, culture, unconscious process, and social differences and power in order to make good sense of it.

Foucault refused to give priority to individual creative subjects. In the work of the archaeological phase he is at pains to erase this essentialising tendency associated with notions of depth or interiority. It is this subject, privileged as the prediscursive origin of knowledge, which Foucault is sometimes claimed to have dispensed with as but one contingent construal of reality when he evoked his simile of man as a figure drawn in sand at the ocean's edge, soon to be erased by the incoming tide. But given this, McHoul and Grace (1993) claim, Foucault never argued on behalf of the radical structuralist idea that there are *no* subjects; that the subject can be 'deleted' from philosophical thinking. The transient subject is rather a transient fold in the order of discourse.

He set aside the taken-for-granted idea of an autonomous and sovereign subject and routinely turned his inquiries to the historical conditions which made various types of quite specific and differentiated subjects *possible* in the first place. His interest was more in how particular kinds of subjects are *produced* as effects of discursive relations. He analyses how processes of subject-production, or subjection, are effected by modern scientific forms of knowledge. In his view it is the idea that all experience has an essential core of hidden truth that enables normalising and in the final analysis, oppressive systems of thought and behaviour to function. And by subjecting 'man' to a ceaseless historicisation, Wolin (1992) suggests, 'his' essential finitude, the impossibility of being his own Origin, is laid bare for all to see.

> If there is one approach that I do reject...it is that...which gives absolute priority to the observing subject, which attributes a constituent role to an act, which places its own point of view at the origin of all historicity - which, in short, leads to a transcendental consciousness. It seems to me that the historical analysis of scientific discourse should, in the last resort, be subject, not to a theory of the knowing subject, but rather to a theory of discursive practice. (Foucault, 1970, pxiv)

Discursive regularities might best be seen as the structuring principles which govern beliefs and practices, 'words and things', in such a way as to produce a certain network of material relations. If discursive rules can only be described or analysed by way of specifying historical conditions, then the local and the contingent assume extremely important functions. But because locality and contingency are caught up within power relations, then discourses can be seen to function in relation to power. Power is

inextricably caught up in social processes. However in this archaeological phase of his work Foucault fails to acknowledge this. This is a major criticism of the work in this period (see McNay, 1992), in that in omitting to tease out the issues of power in social analysis Foucault eradicates the whole social context of discourse. My intention is not to dispute the importance of method of archaeology. Unquestionably it provides a matrix of critical tools indispensable for any study of discourse. My intent is rather to suggest that in neglecting to make his conceptualisation of power explicit Foucault fails to acknowledge the social embeddedness of discourses.

This is a crucial concern for any work on girls in school mathematics. My interest is in exploring how individual students come to occupy certain discursively constructed subject positions at the expense of other discursively constructed subject positions. Because the archaeological method fails to incorporate a theory of power into the analysis of discourse it is unable to provide clues as to how this might be possible. Furthermore it is pessimistic towards the suggestion of interventional possibilities. A progressive politics of girls in mathematics education that offers possibilities for social critique and renewal is simply not serviced at the archaeological phase because an adequate theorisation of the relation between politics and education is not addressed. It is within Foucault's later stages that we see a reformulation of these relations.

3.    *Genealogy*

The most critical attention of all Foucault's work has focused on the genealogical phase. It is here where Foucault traces the making of identities, selves, social norms and institutions. The notion of genealogy itself is central to Foucault's work on power and it is in his essay "Nietzsche, Genealogy, History" (1984) that it first emerges as a crucial concept. Genealogy is perhaps best considered as a methodological response to the problem that informs his work in this phase, namely, the content and nature of the historical present. Foucault's response is a characteristically unique interrogation into the history of the present. He calls his project *an ontology of the present*. It has aroused much interest in that it departs from the methods of his previous work, for Foucault's genealogical analyses are not probed through a quest for the foundations of knowledge and systems of knowledge. Rather, they are attempts to question the necessity of dominant categories and procedures. But this is not to suggest that the method itself is merely a play on rhetorical possibilities. Foucault insists that the genealogical method is *not* an intellectual game. He argues that his method is a serious attempt to explain how the "knowledge which is ours today" (Foucault, 1991, p70), and especially knowledge of man, could come to exist.

In traditional historiography the passage of time is represented as a logical flow of causally connected events, each of which has a discrete significance and forms part of an overall pattern or meaning to history. Events are explained with regard to universal schemas and thereby given a false unity, depriving them of the impact of their own uniqueness and immediacy. Located at the centre in the movement of history is the individual self-reflective subject in whom the logic of identity obtains. Thus history is interpreted as the revealing and affirming of elements of essential human characteristics. In this way history reconfirms one's present sense of identity and suppresses any potentially disruptive awareness of alterity or 'otherness'. Against this Foucault claims that historical events have no essence, or, more correctly, that their essence is fabricated in a haphazard fashion. It is my contention that this claim - one that directly implicates the status of the individual - is both momentous and contentious for feminist politics whose preoccupation has customarily been with the question of the origins of women's oppression. I want to return to this problem and its critique shortly.

Foucault makes this claim by adopting a distinctly Nietzschean methodological approach (Wolin, 1992). By connecting effective history (or genealogy) to the idea of an analysis of descent or emergence, Nietzsche had earlier taken issue with traditional historical analyses and had abandoned the mainspring hermeneutic search for an exact essence of things, that is, the search for the origin of the founding moment that will explain everything. In exposing the 'will-to-truth' that lay behind talk of 'reason' and 'truth' and 'essence', Nietzsche had argued that truth is a purely rhetorical construct. Foucault draws on this Nietzschean realisation of the situatedness of meaning and truth in his own critique of the assumed primacy of truth over ideology. With an understanding of force as prior to meaning, he commits himself to an anti-idealist research programme, one which holds that "truth is a thing of this world" (1984a, p72). In this way he is able to sidestep the question of causality and bypass the metaphysical problem for the search for origins and the originary subject. And in so doing he provides a unique and original approach to culture involving two interrelated dimensions: a challenge to accepted ways of conceiving of our historical present and a reassessment of the methods by which power had been previously analysed.

Foucault argues that a history of the present cannot be hermeneutically systematised and interpreted in terms of the meanings it reveals, but must be understood as a conflict between different power blocks. It is the task of the genealogist to discover how these discourses of truth operate in relation to the dominant power structures of a given society. Thus his genealogical analyses draw on a revised notion of discourse or discursive formation, rather than ideological theory. Fraser (1989) has noted that Foucault's

genealogical method groups together phenomena that are usually kept separate and differentiates phenomena that are usually grouped together. The methodological strategies that Foucault employs in his analyses of phenomenon to make this possible enable him to avoid any reference to the structuralist internal rules of formation. Instead his genealogical method (sometimes known as the philosophy of the event) looks at relationships and outlines a series of external social forces through which he traces the uneven and haphazard processes of dispersion, accumulation and overlapping that govern the limits of discourse. He includes 'nondiscursive' practices and regularities in this outline.

In responding to the question of our historical present Foucault would begin by asking: What are the institutions and systems of knowledge that can readily be identified? What are the relationships between them within particular groupings which characterise our present era? His objective here is to expose the strategic nature of those groupings of knowledge ordinarily considered to be either relatively independent of power or linked only in a vague or inadequate way to institutional politics. Clearly then the theorising moves away from the archaeological postulation of the autonomy of discourse towards its interaction with the structures that govern non-discursive relations and which set the conditions of possibility for discourse. In this move discourse as an internally regulated formation is replaced by a notion of discourse as determined by and also constitutive of the power relations that permeate the social realm. Through the mechanism of his reformulated notion of discourse Foucault is able to suggest that far from being teleologically governed, the historical processes that give rise to the emergence of events or discourse are in fact discontinuous, divergent and governed by chance. This is a monumental claim in the sense that as it denies historical development its self-evidentiality it simultaneously brackets the whole question of validity and truth. As Foucault puts it:

> The problem does not consist in drawing the line between that in a
> discourse which falls under the category of scientificity or truth, and that
> which comes under some other category, but in seeing historically how
> effects of truth are produced within discourses which in themselves are
> neither true nor false. (Foucault 1980, p118)

Central to the notion that there is no immanent teleology to history, is the notion that history is a process of struggle between different power blocks. Power becomes a pervasive factor of human social life under any condition. This notion of the pervasiveness of power relations necessitates a radical reformulation of the concept of power in general. Indeed Foucault's analysis of the history of the present is closely bound to his extended notion of power and cannot be separated from it. It is this reconceptualisation of power and his unpacking of the normalising processes within everyday practices, Wolin (1992) argues, that is generally considered to be the most radical dimension of Foucault's intellectual work. Since this more explicit and strikingly

original theorising of power has significantly enhanced an understanding of domination in the modern world, it seems appropriate at this point to take a closer look at it.

## Power

Foucault's reformulation of a theory of power moves it from a contemporary and essentially negative idea to a positive conception. Foucault theorised the notion of power as an enabling, constitutive and productive force. As he says:

> What makes power hold good, what makes it accepted, is simply the fact that it doesn't only weigh on us as a force that says no, but that it traverses and produces things. It needs to be considered as a productive network which runs through the whole social body, much more than as a negative instance whose function is repression. (Foucault, 1980, p119)

As we have seen an interest in the development and formulation of power is not unique to this phase of Foucault's work. Indeed a preoccupation for redefining power occurs throughout his work. What is imperative to keep in mind is that Foucault's innovative rendering of power as a positive phenomenon is quite different from traditional socio-political understandings. In these analyses the approach is to equate power with the law and conceive its existence in juridical terms of constitution and sovereignty. Sovereign power is contractual in the sense that it takes the form of a consensual relationship between a 'sovereign' and a 'subject'. McNay (1994) has pointed out that later Marxist analyses of 'the left' also conceive of power as unproblematic. In these analyses power is theorised discursively in the Marxist terms of state apparatus and its ideological representations of power, and is seen to operate through deferred and discursive mechanisms.

Both Marxist and sovereign forms of political theory portray power as negative and repressive, acting on something already constituted. Because of their fundamental conceptualising similarities, Foucault merges these two variants as the juridico-discursive conception of power. McNay (1994) argues that within this conceptualisation both the 'sovereign' who wields power and the 'subject' upon whom the power acts are conceptually prior to the exercise of power in this relationship. That is, power is consequential of, rather than instigative in, their existence in this relationship. The juridico-discursive form of analysis is thus unable to differentiate relations of power outside of the couplet sovereign/subject. It does not have the theoretical resources at its disposal to conceptualise power beyond generalised terms into a productive cause of the relationship. Foucault argues that to limit considerations of power to its sovereign conception seriously underestimates the diverse, multi-form aspect of the relations of force in our society. Furthermore, as McNay (1994) has argued, it provides no explanation as to how these relations are connected and consolidated.

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According to McNay's (1994) interpretation of Foucault's work, the argument is that the juridico-discursive conception of power is now redundant and can be substituted with an alternative understanding. Power should no longer be considered as the homogeneous domination over others by an individual or a group. Foucault takes issue with analyses that express power merely in centralised and institutionalised forms in which an individual or group deliberately imposes its will on others, a conscious or unconscious application upon an individual. He opposes and denies that power is possessed. In a counter juridico-discursive ploy he proposes 'exercise' and 'practice' instead of 'possession'. This innovative strategy grants Foucault immunity from providing a theory about what power is essentially. Indeed he takes issue with certain psychologistic attempts to 'explain' why power takes place is. He suggests that analyses should avoid explaining power in terms of intentions, motives, aims, interests or obsessions. For Foucault what is important are the historical conditions which enable ideological productions. His consuming interest lies in the effects of power's exercise. As he sees it then, analyses should be focused on a consideration of the *effects* of power rather than the *explanations* for its exercise.

Foucault claims that power underlies all social relations from the institutional to the intersubjective. It is local, continuous and present in the most apparently trivial details and relations of everyday life. Since power is instantiated in everyday social practices and relations, analyses should avoid its most centralised forms and focus instead on the local and regional points of the destination and on the diverse and specific manifestations of power. Power circulates in practices in the sense that it is employed and exercised through a web-like structure in which individuals are its vehicles. Furthermore power is 'capillary' in its operation in that it works through the lowest extremities of the social body in everyday social practices. In order to understand the operation of power, one needs to understand the particular points through which it passes. Foucault claims that one needs to investigate the historical 'conditions' of the mechanics of power in ascending order of social levels That is, one needs to look to the fringes or to the micro-level of society, for example, to the practices and methods of power's exercise in the classroom, to investigate how mechanisms of power have been "invested, colonised utilised, involuted, transformed, displaced, extended" (Foucault, 1980, p99) by more general forms of power, leading to those types of social domination that are readily identifiable.

## Power-knowledge

In Foucault's radical theorising, power cannot be dissociated from knowledge. His most well-known formulation of this relationship is the power/knowledge nexus. On the one hand all knowledge is the effect of a specific regime of power and on the other hand, forms of knowledge constitute the social reality which they describe and analyse. His argument is that power and knowledge directly imply one another; that there can be no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not simultaneously, presuppose and constitute power relations. This is not to suggest that Foucault redefines power as coextensive with knowledge. It is precisely because he maintains that they are different categories, that he has been at pains to study the question of their relation. He conceptualises every relation between forces as a power relation, where force is never singular but exists in relation with other forces, such that force is already a relation. Clearly then the objective of his genealogical method is to lay bare the political and strategic nature of those clusters of knowledge ordinarily considered to be either relatively independent of power or linked only in a vague or inadequate way to institutional power.

## Power-knowledge-truth

Foucault connects his notion of power-knowledge in a circular relation with 'truth'. He links truth with *systems* of power which produce and sustain it, and to *effects* of power which it induces and which extends it. He argues for an understanding of both power and knowledge as inseparable, mutually supporting and inevitable elements in games of truth. Taken together these three - power, knowledge and truth - become coordinates that constitute all human relationships. By means of this conjunction he discredits the absolutism, the universality, and the *a priori* necessity of Truth that derives from ideological systems of thought. Wolin (1992) claims that Foucault is not in the least interested in systems of 'ideology' per se. His interest lies in the effects of the power-knowledge nexus, made manifest through different discourses or discursive formations.

## Regime-of-truth

Fundamental to power-knowledge effects through discourse is the notion of a 'regime of truth'. This is the stage of his work in which the notion of historically specific regimes of truth is woven together with the concept of the production of knowledge. Foucault suggests that every society produces its own truths and what is taken as 'true' in all social interaction is not to be considered as universal nor indeed even necessary. Specifically in present-day Western society the regime of truth includes discourses of the human

sciences which include the discourses of education, psychology, medicine and law. They become intelligible through their reliance on certain techniques and are accepted and made to function as true, drawing their authority from the sanctioning of the methods and norms of science. Those assigned the task of the production (the intellectuals), or the regulation (the professionals), or the distribution (the media, politicians, the teachers, among others) of what counts as true are accorded appropriate status:

> Each society has its regime of truth, its 'general politics' of truth: that is, the types of discourse which it accepts and makes function as true; the mechanisms and instances which enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true. (Foucault, 1984a, p73)

In his major works of this phase - "Discipline and Punish" (1977) and the first volume of "The History of Sexuality" (1981) - Foucault calls into question modernity's regime of truth when he analyses two major technologies of power, namely, 'discipline' and 'confession'. He maintains that modern regimes of truth that developed gradually in the late eighteenth century mark a shift from sovereign power which is overt, visible and located in a monarchal structure, to 'disciplinary' power which is exercised through its invisibility via normalising strategies. Even as the two forms of power employ quite different strategic operations, modern disciplinary power has much in common with sovereign power precisely because it progressively blocks rather than widens the scope of freedom from inequality and oppression. In our present era 'disciplinary power' assumes greater homogenisation than traditional power insofar as it constitutes a new form of pastoral power. It is also totalising in that it is constitutive of all social interaction. It is effective as a normalising force because it is relatively invisible in its operations. That is, individuals are regulated not only through overt repression but also through a set of standards and value systems associated with normality which are created and maintained in subtle and diffuse ways. Taking the argument to its obvious conclusion is to suggest that the Enlightenment notions of progress and rationality have degenerated nowadays into an instrumental logic that pervades even as it synthesises social practice.

> Traditionally, power was what was seen, what was shown and what was manifested...Disciplinary power, on the other hand, is exercised through its invisibility; at the same time it imposes on those whom it subjects a principle of compulsory visibility. In discipline it is the subjects who have to be seen. Their visibility assures the hold of power that is exercised over them. It is the fact of being constantly seen, of being always able to be seen, that maintains the disciplined individual in his subjection. (Foucault, 1977, p187)

It is in "Discipline and Punish" that Foucault traces the transformation from a system of justice expressed through violent spectacle to one that rationalises punishment with the modern power techniques of imprisonment and surveillance. He contends that the operations of modern disciplinary power in the penitentiary are constituted by power relations directly linked with systems of knowledge. Tactics and techniques employed in penal institutions can also be shown to function in modern disciplinary practices. As the

most well-known of these practices, 'the gaze' represents a technique of the power/knowledge couplet which enabled administrators to control those in their care.

In the first volume of "The History of Sexuality" Foucault's interest moves beyond the control of individuals through overt expression in the modern penal institutions of "Discipline and Punish" to consider regulation and normalisation through relatively invisible means. In his analysis of contemporary notions of sexuality Foucault argues that in a social organisation dedicated to the administration of life, a crucial task must be the compiling of knowledge about the individual, which has much to do with the investigation between the 'normal' and the 'abnormal'. The adjudicators of normality assume their positions both within and beyond the ostensibly benevolent medical forms of knowledge. They are located in society as the teacher, administrator, economist, legal adviser; indeed in any form which assesses and diagnoses the individual in accordance with a normalising power base, which Foucault calls the 'carceral' (penitentiary) network of power-knowledge.

Foucault is at pains to argue in his attack on psychoanalysis (Foucault, 1980) that individuals are controlled through modern forms of both disciplinary domination and counter-power resistance because both are already implicated within the horizon of the power-knowledge network. Thus for him the apparent liberatory practice of medical 'confessions' is a fiction since, in effect, it serves to implicate individuals even deeper into the complex of disciplinary power. The necessity to examine one's inner self and to confess becomes so deeply urgent in the modern subject that it is no longer regarded as coercion, but is perceived as an act leading to greater self-knowledge. Masquerading as a medium for greater self-liberation the disclosure of one's inner self and unconscious desires is in fact an effect of material processes of subjection. But rather than producing conformity and regularity explicitly, the effects of the processes of normalisation are in fact obscured behind the shield of individualisation. Those very distinctive features of one's individuality - the differences, peculiarities, deviance and eccentricities - are sought out and named through the processes of normalisation and subsequently marked as 'personality' traits. The very notion of a 'personality' derives from this process: as power becomes more pervasive, those upon whom it is exercised tend to be more strongly individualised.

> The individual is not to be conceived as a sort of elementary nucleus, a primitive atom, a multiple and inert material on which power comes to fasten or against which it happens to strike, and in so doing subdues or crushes individuals. In fact, it is already one of the prime effects of power that certain bodies, certain gestures, certain discourses, certain desires, come to be identified and constituted as individuals. The individual, that is, is not the vis-à-vis of power; it is, I believe, one of its prime effects. (Foucault, 1980, p98)

In exposing the relationship between individuality and modern techniques of power, Foucault is able to historicise power and offer a new perspective on the configuration of our historical conditions. And through his momentous theoretical departure from totalising historical analyses and their self-thematising subjects, he is able to change the meaning of historical development. For him history is not a matter of one's interaction with and reflection upon the world and reconciling any inherent contradictions. Foucault's argument, as has already been noted, is that history is the result of a constant struggle or warfare between different power blocks which attempt to impose their own system of domination. But what has not been argued with any degree of clarity above is that this historical struggle between different power formations is, as McNay (1994) clarifies, centred on the human body and acts upon and through it in a way which is unable to be explained from a totalising historical perspective. Thus it is the body which is the pivot of history.

It is by formulating his theory of the body around a notion of discursive practices that Foucault is able to give an account of how the individual is 'produced' by the endless repeated play of domination, both shaped and reshaped by the different warring forces acting upon it. This general idea of the body that resists hermeneutic interpretation in terms of the meanings it clarifies is a concept central to much of what is categorised as poststructuralist thought. Indeed many poststructuralists centre their methods upon the body itself in order to set in motion their attacks on the rational subject or cogito of classical thought[6]. Their deconstructive methods endeavour to show how the body has been excluded from ideas of rationality and self-reflection. By focusing on the body rather than repressing its materiality and its desires, poststructural thought aims to dislodge the concept of a coherent and self-determining subject.

On a fundamental level, a notion of the body is central to orthodox analyses of the oppression of girls in mathematics schooling. The histories that such research presents are built and legitimised upon gender inequality as the biological difference between male and female bodies. In the work of the 'women as a problem to mathematics' tradition the idea that women and girls are inferior to men is naturalised and thus legitimised by reference to sexual difference. This girl of school mathematics takes the social structure as given. At the core of her being is an essential self. And precisely because she is a biological female she is interpreted in gendered terms as dictating a certain identity, always situated in a world of universal roles and expectations. The girl of the woman-

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[6]     Foucault's insistence on the body as the pivotal point of history distinguishes it from Derrida's concept of the body. For Derrida the body is a metaphorisation of the more general philosophical problem of difference. Feminists have been drawn to Foucault's stress on specificity more so than to Derrida's representation of the feminine body because the latter bypasses altogether the question of sexual difference as it relates to the experiences of women.

centred approach is also circumscribed by essentialism but for her the roles are reversed. For her, too, essence precedes her and is prior to the social field. She is also a situated self, constituted by social roles, but for her, identity must be renegotiated and the social order reversed.

## The Problem of the Docile Body

The problem for mathematics theory and practice in gender work lies in posing the question of the body beyond these terms so that it might untangle itself from the masculinist construction of an essentialised self. The initial appeal of Foucault's theory of the body for this work at hand on girls in school mathematics is that it offers a way out of this impasse and hence is able to contribute significantly to the field. His is an anti-essentialist conception that locates the body at the centre of struggle for domination through discourse. For Foucault the body is an historical and culturally specific entity and in its elaboration without recourse to an original sexual difference it assumes a radically new meaning. It is a concrete phenomenon that does not establish its materiality with a fixed biological or prediscursive essence. It is this conceptualisation that presents a way of preserving the body at the centre of explanations of girls' oppression in school mathematics even as it evades the notion of essentialism or biologism.

However Foucault's notion of power is not so easily accepted since it cannot be contained within certain disciplinary practices. The problem for emancipatory practice arises in the slippage from describing disciplinary power as a tendency within modern forms of social control to one which saturates all social relations. Inevitably Foucault's definitions and depictions of power become conflated with social action to the point where power is everything and everywhere. That is, any act whereby one person influences, persuades or convinces another is seen as 'power over'. By casting power as omnipresent Foucault suspends the problem of legitimacy. Since if there is essentially no such thing as the legitimate exercise of power, then those who contest power must necessarily exchange one set of coercive practices and controls for another. Their struggles are condemned *a priori* to reproduce the very practice they are contesting. Fraser (1989) criticises this point when she observes:

> The problem is that Foucault calls too many different things power and simply leaves it at that...Clearly, what Foucault needs, and needs desperately, are normative criteria for distinguishing acceptable from unacceptable forms of power. (p32-3)

Habermas (1987) has accused Foucault of a 'crypto-normativism'. By this he means that Foucault's work does not have a clear normative framework. It does not consider the other dimension of power, 'power to', or 'power as freedom'. The problem arises from

Foucault's failure to recognise the extent to which the normative is embedded and infused throughout the whole of language at every level and how his own critique inevitably relies upon modes of description, interpretation and judgment drawn from the modern Western normative tradition. As Wolin (1992) has argued, this raises the question of whether Foucault - for whom all claims to right are functional in the sense that what one side in a dispute invokes as 'right' will be perceived by the other side as a usurpation of 'right' and vice versa - can provide us with any reason as to why we should strive to transcend conditions of domination. For if emancipation is structurally impossible, one can only postulate an infinity of different power formations in an a-moral universe with no hope of getting beyond their cyclical recurrence. It leaves no space at all for any possibility either of liberty or of social progress. Taylor (1985) puts it like this: in Foucault's narrative, "there is no escape from power into freedom, for such systems of power are coextensive with human society" (p153). We can only step from one domination into another.

Feminists have been quick to point out the consequences of the idea of docile bodies for theorising gender. Gender presents as an effect of dominant power relations imposed upon the inert bodies of individuals, rather than as a dynamic process. McNay (1994) argues that this leads to an overestimation of the efficacy of disciplinary power and provides an impoverished account of the construction of gender identity in which sexual difference is reified. Implicit within this static model lies the assumption of gender identity as unproblematic and total which renders the model unable to account for the individual experiences that fall outside the realm of the 'docile' body. This is a particular problem for my work given that a significant focus of my project is in understanding the agency. Undue emphasis upon the effects of a corporeally centred disciplinary power closes down any explanation of how individual students may act in an autonomous fashion and in turn, denies how such autonomous actions may lead to progressive social change.

The problem is that Foucault treats the body as an undifferentiated or neutral gender, refusing to enter into the dispute about the nature of embodiment in general. Sexual difference, Braidotti (1991) argues, appears to play no role in the Foucauldian universe. For him the technology of subjectivity refers to a desexualised and general 'human' subject. This is a major concern for many feminists who argue that what Foucault fails to do is demonstrate how sexual division is perpetuated by the disciplinary regime of gender that is applied to the body. Bartky (1988) suggests that in failing to examine the gendered character of many disciplinary techniques on the body - the various practices and discourses channelled towards women - Foucault is unable to explain how men and women relate differently to the institutions of modern life. Braidotti takes up the point: "Foucault never locates woman's body as the site of one of the most operational internal

divisions in our society, and consequently also one of the most persistent forms of exclusion" (p87).

This is not to suggest that my aim is to retrieve young women from their immersions within male categories, values, and norms. What I have in mind is more in keeping with Riley's (1988) argument: "the body circulates inexorably among the other categories which sometimes arrange it in sexed ranks, sometimes not. For the concept 'women's bodies' is opaque, and like women it is always in some juxtaposition to human and to men" (p107). Riley's argument provides a sound foundation for theorising the girl in school mathematics. Like the category of 'woman' in which it is caught up, the female body is an historically variable construct and not completely separate from that of the male body. And up to this point Foucault would agree. But where Riley differs in argument is in her suggestion that the body is socially and discursively worked upon by gender constructions. But more importantly, it is also inscribed by other institutional mechanisms of formations such as class and race, which may or may not be internally gendered. This is to suggest that it makes little sense to speak of body constructions in terms of an eternal, undifferentiated opposition between the sexes. It seems more appropriate to regard female bodies as worked upon in both socially and historically specific ways.

The paradox that presents for me is that in prioritising the effects of historical conditions upon the body of the girl in mathematics, Foucault denies her status through autonomous action. This is because, as McNay (1992) argues, Foucault formulates his category of the 'docile' body in such a way that no notion of positive agency can ever be activated. This formulation reduces the diversity of the school girl's mathematical experience and creativity to the effects of unifying bodily discipline. She is little more than a 'place filler', as Norris (1993) has pointed out, a recipient of moral directives which issue from some other source of authority. This idea of reception has significant implications for this work on girls in school mathematics: firstly, it fails to explain how the girl's actions are constantly mediated through interaction with others. Secondly, it denies an understanding of the girl as a thinking, willing and responsible agent of choice in individual efforts or in joint and collaborative enterprise whereby she might overcome the limitations and inequalities of the social realm in which she lives. And ultimately it negates any possibility of wider progressive social change. It is with regard to this sense of closure that some critics have labelled Foucault's method of thought which I have discussed here in this chapter, as characterised through his earlier works, as a 'counsel of despair', and have accused him of adopting a highly irresponsible 'anarchic Nietzscheism'.

## Conclusion

Without any doubt Foucault's genealogical analysis achieves a history which tends to undermine the unquestioned legitimacy of the present by offering a re-creation of a different past (Poster, 1990). And it is his strikingly original reformulation of power that is one of the more valuable aspects of his theoretical legacy. His notion of power as essentially productive has contributed to our understanding of the various manifestations of domination in the modern world which fall outside the purview of the juridical model of power. But it does more than this: it denaturalises understandings of human subjectivity by drawing attention to its essentially constructed nature and by implication its open-endedness and mutability. This is important for my work because it suggests how we might look at the practices which those designated 'girls in mathematics' are defined and regulated. But given that, in a very real sense, Foucault's notion of power, in this earlier work, falls short of his intentions. In a very real sense his critique of power and normalisation argues against any form of emancipation from the grasp of oppression. Crucial for me, it does not provide a space for agency. However, a space for agency *is* made available in Foucault's later works. It is these to which I turn in the next chapter.

## CHAPTER FOUR:

## Refining Theory
### or
## Possibilities in Foucault's counter history of ideas

> There are times in life when the question of knowing if one can think differently than one thinks, and perceive differently than one sees, is absolutely necessary if one is to go on looking and reflecting at all. (Foucault, 1984c, p8-9)

### Introduction

Research in mathematics education which is primarily concerned with questions about school mathematics as a social institution needs theory which can address forms of social organisation. It requires a theory which is able to address the positions that are occupied within its realm and account for the social meanings and normative systems which support or contest the forms and functions of these positions. Research that is able to engage with the realities of girls in mathematics education must register a set of overt commitments to theory which will ultimately provide analytic tools for describing mathematics educational practice.

In this work the question of theory is centred around the question of the theoretical positions offered by Foucault as advancing gender work in the field. I begin by setting out those ideas and constructs, discussed in the previous chapter, which I see as useful to the field, and turn to a consideration of how those ideas have been utilised in educational analyses. The problem which then confronts is the extent to which Foucault's ideas about domination and the constitution of human subjects as docile bodies conflicts with, or even undermines, an emancipatory politics in mathematics education. I then pose a rejoinder to this difficulty in Foucault's work by looking at his final work in which he elaborates a notion of the self. I suggest how this concept of the self overcomes the limitations of his earlier theorising and how it might be useful for mathematics educational research in general and specifically for work on girls in school mathematics. What I want to explore is what an engagement with Foucault's final work, which critiques the foundations and the status of the individual, might do for, and demand of, this work. Implicated in this discussion are the questions that his formulations of discourse, subjectivity and power pose for an understanding of how girls become gendered learners in the mathematics classroom. My goal is to establish a potentially productive point of convergence between his radical thinking, and work on gender in mathematics educational research.

## The fundamental question of mathematics educational research

Theory that is useful to mathematics education should be able to respond to the fundamental question of inquiry: How does research understand the subject and her relationship with her world? Research cannot begin to make sense of social forms and functions until the notion of the subject is unpacked, that is, until assumptions of subjectivity are made. Humanist assumptions that underpin commonsense liberal feminist views of subjectivity presuppose an essence at the heart of the individual which is unique, fixed and coherent and which makes her what she is. Such views of subjectivity tend to reiterate that individuals are born with a human potential which, given the right environment, can be realised through education and personal development.

In the previous chapter it was argued that in mathematics education literature the basic assumptions and beliefs which have up until now been fundamental to a progressive politics for girls in schooling are drawn from liberal humanist thinking. Like the labouring Marxist subject, the Kantian transcendental subject, the psychological ego, and the sociolinguistic language user, the liberal humanist subject of mathematics education effectively closes off any discussion of always-already existing social structures and relations of power. Even as categories of boy/girl and their derivative terms masculinity and femininity, might instil contradictory meanings in society, nevertheless we are, it is claimed, assumed to be whole and coherent subjects with a unified sense of identity, with a fixed core or essence. The explanation implicit is that making sense of notions such as masculinity and femininity is a knowledge that is learned through experience and this experience is expressed in language. The motivation for this explanatory tactic lies in an assumed unproblematic relationship between the individual, experience and language which allows little scope for theorising contradictions either in our sense of ourselves or in the meaning of our experience. It could also be said to practise a complex form of marginalisation which ultimately serves to inhibit its analyses.

Increasingly other fields have been drawn to Foucault's philosophical critique of the rational subject as a means to circumvent the limitations of essentialist theorising. It would be useful at this point to recall that 'subjectivity' represents a theoretical development from the notion of the 'subject' in structuralism:

> The 'subject' is the generic term used in philosophy for what in lay terms would be 'the person', 'the individual' or 'the human being', and what in psychology is referred to as 'the individual'. The term 'theories of the subject' has tended to refer to approaches which are critical of psychology's assumptions about individuality, theoretical approaches which emphasize the way in which the social domain constitutes the individual, rather than the other way round. (Henriques et. al., 1984, p93)

> We use 'subjectivity' to refer to...the condition of being a subject - but understand in this usage that subjects are dynamic and multiple, always positioned in relation to discourse and practices and produced by these. (Henriques et. al., 1984, p3)

The subject, as Usher and Edwards (1994) note, is always in caught up in a movement, inextricably involved in an on-going changing relationship between herself and that which she knows. In the French language Derrida (1978a) has named this movement as *différance*. The word sets itself up as a disruption to the ever-familiar notions of the individual which are described by the logic of identity's trajectory. It does this not by posing as a new oppositional logic but as a challenge to the wholeness, the totality and closure of the spectrum divided by binary pairs. According to Derrida, fixed oppositions conceal the extent to which they are in fact interdependent and hierarchical. In other words binary pairs derive their meaning from a particularly established contrast where one term is prior to or dominant over the other. In Chapter 1, I discussed how this binary oppositions plays out in the construct of 'female nature'. Scott (1988) and Lloyd (1984), among others, have taken this point further to argue that the western philosophical tradition itself is founded on binary oppositions such as unity/diversity; identity/difference; masculine/feminine; and presence/absence.

This notion of difference, whereby meaning is made through implicit or explicit contrast, has appealed to a number of social analysts. Feminist scholars have noted how oppositions rest on metaphors and cross-references which serve to encode or establish meanings that are literally unrelated to gender or the body. In analyses of meaning which seek to unearth negations and oppositions the meaning of gender is seen to become tied to many kinds of cultural representations and these in turn establish terms by which relations between women and men are organised and understood. These analyses draw on Derrida's notion of *différance* to provide an insight into the way meaning is constructed. The question of difference for Derrida[1] is a question of suspending temporal-space in which the 'whole spectrum' can never be complete. *Différance* marks all totalities as merely localities dependent on relationships. To capture this understanding Spivak (1989) proposes the English translation *deferring* as more in keeping than the word *differing* with Derrida's intentions for *différance*. It is a difference which is no longer reducible to an opposition between identity and difference. Rather, it defers the identity of either term against a play of identification and differentiation which never fixes either identity or difference. It shifts the focus of the act of valorising the subject from the realm of essential and unchanging ontological conditions to the realm of provisional and partial claims.

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[1]      Derrida writes of this difference which he claims can no longer be reduced to a binary opposition between identity and difference: "Here there is a kind of question, let us call it historical, whose *conception, formation, gestation* and *labour* we are only catching a glimpse of today" (1978a, p293).

Socialist feminists in particular have been drawn to these poststructural arguments of the subject and have taken them together with Foucault's notion of power in order to criticise their more radical sisters' acceptance of essentialist ideas of the individual. For Foucault there is no originary moment establishing pure identity which can be rationally unpacked, but only a flux of experiences, ever being shaped into new wholes, reproduced through new vocabularies and new stories. These ideas have been taken up to a much lesser extent in the educational arena. Social analyses which do engage with Foucault's work draw on his decentring of the subject and the way that it problematises unitary and universal categories such as boy/girl, traditionally regarded in research as natural, and historicised concepts such as equality/justice that are commonly taken as absolute. His notion of subjectivity appeals in that is presents an open-ended, contradictory and culturally specific cluster of different subject positions, constructed by discourse. This is seen to be a useful strategic device for contemporary feminist analyses because Foucault's deessentialising manoeuvres resonate strongly with the feminist critique of rationality[2] as merely a masculine construct, and clears yet another space for denial of the claim that women/girls are *essentially* different from men/boys. Taken together these two theoretical convergences in poststructuralist and feminist notions of subjectivity can be made use of in my work as a way of overcoming some of the limitations of gender work in mathematics education.

To see gender as neither fixed nor finite is to occupy a very different position in authorising what can count as legitimate knowledge and experience. This might be seen as a radical or subversive move in the politics of the knowing subject and one which is detrimental to the feminist cause. However the opposite is more the truth of it. In its denial of essentialism Foucault's theorising is able to relate the individual woman/girl to the social and thus view her social constitution as subjected to different social relations and processes from men/boys. In other words it recognises the importance of the subjective in the constitution of the meaning of girls' lived reality and is able to relate this to an understanding of power. Who the girl 'is' and who she 'becomes' is determined by what is said (and unsaid) *to* her, and what is said *about* her. As Confrey (1990) has written in the mathematics education literature, modes of understanding become available through social structures and processes and hereby provide a perspective to the individual: "we construct our understanding through our experiences and the character of our experience is influenced profoundly by our cognitive lenses" (p108). The decentred subject is offered an explanation of where her experience comes from, and why this

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2        Later, in chapter 6, I elaborate more fully on the feminist critique of rationality. It is mentioned merely in passing here to signify that body of work being carried out by feminists which, aligns itself with the poststructural position in subverting the notion of essentialism.

experience might be contradictory or incoherent, and why it might be different from the experience of others (Weedon, 1987). This is done by claiming that all knowledge is linked to power and as such is contested, and is merely temporal and emergent.

Foucault's poststructuralist deessentialising of 'the subject' allows an understanding of the subject as a position within a particular discourse. It follows from this that the subject is no longer isomorphic to the individual. Rather the power/knowledge relations which produce a subject-position imply that there need not be any coherence to the multiple sites in which subject-positions are produced, and that these individual sites might themselves be contradictory. For the girl in schooling, the social institution of her classroom, her family, the world of leisure, fashion and so on, are all prior to her being. She learns about their operational regimes of truth and the values which they maintain as true. Hence her subjective experience, that is, the way in which she make sense of her school life leads into an understanding of how power relations structure society. Meanings become enmeshed in discursive battles that influence, dominate, parody, translate and subvert one another. And the girl becomes dynamic, expansive and intrinsically shaped by power.

> This form of power applies itself to immediate everyday life which categories the individual, marks him by his own individuality, attaches him to his own identity, imposes a law of truth on him which he must recognise and which others have to recognise in him. It is a form of power which makes individuals subjects. There are two meanings of the word subject: subject to someone else by control and dependence, and tied to his own identity by a conscience or self-knowledge. Both meanings suggest a form of power which subjugates and makes subject to. (Foucault, in Dreyfus and Rabinow, 1982, p212)

The methodological significance of abandoning belief in essential subjectivity lies in its capacity to generate new methods of analysing constructions of meaning and relationships of power. Questions of difference and the body factor into the analysis more in terms of how the body is invested with certain properties and the ways in which it is placed into regimes of truth, rather than with the questions concerning the body's essential core. The consideration centres around the relationship of the body to the discursivity and the historical presence of the everyday school life of girls. In these analyses the starting point is with the body and the task is to analyse the effect of power in its most specific and concrete forms. The interest is in examining the way in which the body is constructed in order to legitimise different regimes of domination; to show how power relations are embodied without depending on the mediation of the subject's own representations. The focus is not on the meanings which the girls attach to their activities or ways of thinking, since the interest goes beyond the role of language and textuality. Its explicit consideration is of the nature and role of power and the mechanisms whereby domination and power consolidate their hold on girls in schooling.

Foucauldian approaches to educational research span the domains of philosophy of education, teacher education, curriculum, minorities' and girls' interests, and research itself. Britzman's (1991) and McWilliam's (1992) interest has been with teacher education. Both have examined teacher education as an arena where dominant sociocultural discourses compete to construct and position teachers and students. Extensive work has been carried out in the curriculum field to scrutinise the construction of particular areas of school knowledge and curriculum in texts and in classroom interactions. An important and widely read work in the curriculum field of mathematics is that of Walkerdine (1988). In other subject areas the work of Baker and Freebody (1989), Gore (1995), Jones (1997), Luke (1988), Middleton (1995), and Singh (1993) figure as significant. McElroy-Johnson (1993) and Nieto (1992) work specifically for the advancement of minority students. Ellsworth (1992) draws on Foucauldian ideas in a consideration of her own teaching practice. And for both Lather (1991; 1992) and Cherryholmes (1993) the interest is in theoretical reframing of educational research. Their work looks at the possibility of moving data collection, analysis and experiment to an understanding as discourse practice.

In the sparse Foucauldian research in education which works on behalf of girls' interests, understanding who the girl 'is' involves unearthing the physical, social and discursive mechanisms by which she is produced. It moves from a concern with behaviour, skill and mind towards the notion of discourse as a constitutive pedagogical category. Its purpose is in revealing how pedagogic discourse is implicated in systems of government, surveillance and moral regulation. The recent work of Cherland (1994); Christian-Smith (1993); Davies (1989, 1994, 1997, 1998); Fine (1992); Gilbert & Taylor (1991) and Rhedding-Jones (1997) all draw on the Foucauldian concepts of discourse and subjectivity in their analyses to seek an understanding of how 'the girl' has been constituted out of particular systems of subjugation. This they do by tracing the circuitous paths by which the girl's constitution takes place. The particular interest is centred on the mechanisms through which a form of personal existence is created for the student within the classroom by the labelling of the category 'female learner' to her, her actions and her classroom relations, given that the discursive activity of learning positions the student as 'learner' amongst other learners, as well as amongst 'others' within the educational apparatus.

Each of these analyses shares a common concern to move beyond a-historical and depoliticised notions of educational research. The intent for each is to discover how the discourse of the classroom, or 'regimes of truth', operate in relation to the dominant power structures of a given society. To do this these analyses explore how a multiplicity of what Foucault calls 'micropolitics' prohibit or sanction certain effects on learning in

everyday practices in general and, in particular, on the dispositions of the girls and others they subjugate. The way in which this is undertaken varies immensely. There is no one conceptual strategy, approach or language that defines their practice but each takes account of the inherent perspectivity of knowledge production and the unavoidable open-endedness that this entails. In its own way each piece of research critiques what seems 'natural', recasts 'experience', unsettles received definitions, multiplies subject positions, and connects the 'voice' to the structural and the collective.

## The question of power and possibilities for agency

Foucault's ideas have provided a useful analytical framework to explain how girls' experience is controlled within certain cultural determinations. In those analyses in which the main concern is with the effective history of girls in schooling Foucault's understanding of the body as the main target of the transmission of power/knowledge relations is able to sidestep the question of difference and the colonisation of the body's 'natural' resources. The difficulty is that in taking on board Foucault's undifferentiated theory of power and its effects on the body for educational analysis is to make a case for the production what Foucault terms 'docile bodies'. 'Docile bodies' are acted upon by disciplinary power through such diverse forms as the architecture of the school, the organisation of the school day into strictly demarcated parts, the disciplining of bodily activity in connection with the traditional textual production of school work, or the normalising of sanctions and systems of developmental progress and of punishment which constantly measure individuals against standard measures. Despite the explanatory power which Foucault's notion of subjectivity presents, in these educational analyses power becomes, to a certain extent, a perjorative term. Assumptions which underlie the notion of girls as innocent victims of social power have already been discussed in the previous chapter as problematic and need not be repeated here. Suffice it is to say that an insistence on girls as passive victims of social oppression either devalues or occludes altogether the complexities of their experience. Such a perspective implies a derogation of the passive body by regarding it as a 'cultural dope' with no meaningful understanding of its situation.

Because I am interested in the possibility of a progressive politics[3] I want to argue that theory that is useful and relevant for political practice must provide an understanding of the girl in schooling as an *active agent* capable of intervening in and transforming her

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[3]     My use of the term 'progressive' is in the sense of furthering the pursuit of a cause rather than delimiting action. Blake, Smeyers, Smith and Standish (1998) speak of 'progressive' as "cultivating a healthy discourse" (p31). Also, see note 5 below for a very brief summary of Foucault's argument.

environment. Yet this whole problem of thinking through adequately the question of power and emancipatory possibilities presents enormous difficulties for gender theorising in mathematics education. When one is motivated by poststructural interests, the question of agency looms as problematic. The same can be said for those working 'on behalf of feminist interests. In feminist theorising the quest is to move the discussion of subjectivity of women and girls beyond notions of passive victims of patriarchy. This is not to deny that there are particular constructions of gender which serve to maintain the general subordination of women in society. But the concern here is how is one to reconcile *that* particular observation with the realisation that many girls and women do not experience themselves as oppressed? Indeed many women and girls exert a degree of power and influence over other individuals. Because current interventionary work on girls in schooling is premised upon a notion of female universality and shared oppression between women and girls, a major difficulty arises. This manifests itself in the attempt to move beyond the notion of *universal* and shared oppression between women and girls while simultaneously elaborating a progressive politics which is to hold *universal* appeal for women and girls.

This is the debate that continues to take place amongst feminist writers.[4] Weedon (1987) points out that this issue was initially raised by women of colour in the United States who argued that a progressive politics must consider gender as merely one of many primary categories. These women argued that although power over women by men was very general and central to an understanding of experiences of women, it is not the only form of oppression that exists. Indeed it is only a few privileged white western women for whom such power is the main form of oppression. In Britain Ramazanoglu (1993) has argued that particular social structures and processes over time have created different conditions of existence for women of colour and of ethnic minorities. At the same time differences exist within each ethnic group. Much the same has been said of the histories and experiences of New Zealand girls: Maori, Pacific Island and white New Zealand girls have little or no cross-cultural homogeneity. An understanding of these differences leads to a consideration of the material and discursive aspects of social structures and processes. It leads to a recognition that these differences have their roots in colonial relationships which inevitably intersect with the problem of power.

These issues beg the questions: Where does Foucault's dissolution of a unified subjectivity lead to in terms of political agency? What does his emphasis on domination,

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[4]     For an interesting discussion on the argument that people choose their subject positions, see Jones (1997), and a reply by Davies (1997). Jones argued that the notion of agency runs counter to some theorists' poststructuralist ideas.

silencing and categorisation suggest in terms of an understanding of individuals in emancipatory practice? What are the implications of Foucault's suspension of all forms of value judgment embedded within the concepts of truth and freedom, for a progressive politics of mathematics education which inevitably relies upon certain assumptions about the constitution of oppression and freedom?

Foucault's work considered so far confines itself to a critique of representations or knowledges, rarely going beyond a discursive analysis of questions of subjectivity and representation. While in no way wishing to demean his efforts for politicising language and knowledge (Nicholson and Seidman, 1995), it seems to me that his decentring move closes off interventionary practice. In its refusal of the concept of the unified or coherent self, it surrenders any basis for political mobilisation. Its critical analyses do not aim at praxis but live in the persistent crisis of the moment (Spivak, 1992). This might suggest the disintegration of motivating arguments for intervening in any research practice whatsoever. It might point to an understanding that there are no longer any means of deciding when, how, and in what to intervene except by intuition, personal profit, and price. It presents an image of an impossibility that cannot be productive for *any* political position, particularly one whose principal aim is in overcoming the subordination of women.

If Foucault's work cannot found a politics how can we create a politically constructive moment for an intellectually deconstructive critique? Recent discussions circulating in the wider academic arena have drawn attention to these crucial limitations of Foucault's thought. The specific argument is that by emphasising the effects of power upon the body Foucault reduces it to a passive entity to be viewed as the product of arbitrary restraints. In these debates it is claimed that Foucault's theory of power and its relation to the individual is unable to reconcile itself with the demands of an emancipatory politics. The question of the Truth about ourselves as knowing, willing and judging subjects, able to act in an autonomous fashion, can find no inherent meaning. The possibility of emancipation is ruled out *a priori*. Instead one becomes aware of the contingency of one's very being. What is devastating in this is that we remain trapped within Nietzsche's dilemma, namely, that if no Truth exists then there can be no possibility of an ethics and a politics possessed of genuine emancipatory values. We are left in a rather difficult situation of either accepting the system as it is or submitting to the chaotic and random changes brought about by discontinuity. Interventional possibilities remain rather pessimistic. Alcoff (1988) puts it this way: "Following Foucault..., an effective feminism could only be a wholly negative feminism, deconstructing everything and refusing to construct anything" (pp417-8).

The same theme is taken up by Bordo (quoted in Nicholson, 1994). She argues that infinite perspectivity and unlimited possibilities of interpretation leave feminism unable to assert itself as a political project with any positive meaning:

> I have no dispute with this epistemological critique or with the metaphor of the world-as-text as a means of undermining various claims to authoritative, transcendent insight into the nature of reality. The question remains, however, how the human knower is to negotiate this infinitely perspectival, destabilized world. (p10)

## A Theory of the Self

An understanding of political agency requires theory that is able to engage with the problem of power and allow for potential self-determination. It should clarify what it might offer in terms of emancipatory possibilities and be able to account for political limitations with regard to individual motivation for change (Weedon, 1987). How is one to formulate a notion of power upon the girl that exceeds universal definitions of passivity?

As I see it, the body of theory which addresses these issues more than adequately is to be found in Foucault's final works: "The Use of Pleasure" (1984c) and "The Care of the Self" (1984b). I believe that in these works Foucault offers a theory which encompasses a more complex and differentiated analysis of relations between gender and power; one that is able to acknowledge the potential of creativity and agency within social constraints. Hence I propose to move gender inquiry in mathematics into some sort of alliance with Foucault's later ideas on language, subjectivity and power. In doing this I recognise that a responsibility to a progressive politics of girls in schooling insists on considerations of both the normative and epistemic realms. I anticipate that the conjunction will serve feminist interests in mathematics education. But above all I anticipate that this proposal will provide clarification of that which I hope to articulate but has not been able to be produced in the literature from within the traditional horizon of modernist thinking.

In his later works Foucault implicitly acknowledges that the emphasis he placed on the effects of power upon the body in his archaeological and genealogical work generated an understanding of social agents as passive bodies and a monolithic and functionalist account of power. Power in his studies of disciplinary practices, he acknowledges, becomes ultimately prohibitory and repressive, setting itself against any possibility of resistance to modern forms of disciplinary domination. In response he initiates a change in theoretical focus, from the body to the self. This he undertakes principally in his two subsequent volumes of "The History of Sexuality" published just before his death in 1984, that is, in the two works noted above, namely, "The Use of Pleasure" and in "The

Care of the Self". This new theorising appears to overcome some of the difficulties of his earlier formulation of power that gave rise to an inevitable cycle in which resistance slides into domination. His approach is through a process which involves the adoption of an attitude of self-critique and the exploration of new modes of subjectivity.

## Governmentality

In his earlier analysis of disciplinary practices Foucault's reconstructions of phenomena were centred within the official discourses. As a consequence he tended to overstate the efficacy of disciplinary power because 'other' conflicting knowledges and discourses were excluded. According to McNay (1994), when these shortcomings were made apparent he sought a more productive understanding of power. It is through his introduction of the notion of *governmentality* that Foucault is able to advance this understanding and offer a more fluid approach to the interpretation of individual experiences. This new understanding continues to preserve the idea that individual subjects are constituted by power. But here power assumes a more diffuse role than the characteristic uni-directional operations of disciplinary power. Rather than being confined to external and impersonal mechanisms and institutions, power becomes more open in its definition. As McNay (1994) points out, domination and resistance are no longer conceived of as ontologically different but as opposing effects of the same power relations. In particular, power becomes both an objectivising and a subjectivising force through the process of differentiating between violence, domination, and give-and-take within everyday relations.

What derives from the notion of governmentality is the idea that individuals are active agents with the capacity to fashion their own existences. That is, whilst governmentality targets the individual as the means with which to maintain social control, at the same time it provides the individual with the very techniques with which to resist this government of individualisation. Foucault introduces the category of the 'self' to capture this idea in an effort to transcend the limitations of the 'docile body'. This move from *body* to *self* opens up new possibilities for gender work in mathematics education because it offers a more complex and layered notion of differences. It suggests an understanding of gender as an active and never-completed process of engendering or enculturation. This in turn suggests a notion of the girl as engendered across a vast number of subject positions, some of which are gendered to a much greater degree than others, *but over all of which she may exert some degree of autonomy.*

## Technologies of the Self

*Technologies of the self* are descriptors for the particular practices and techniques through which the subject fashions her own identity actively. Blake and colleagues (1998) have suggested that they are the ways in which she relates to herself. They influence the ways in which her subjectivity is constituted and her experiences are shaped. Her thoughts and actions are also governed by them. It is these technologies of the self, these fashionings, that were not able to be unpacked in Foucault's earlier notion of disciplinary practices, where they lay dormant under the level of the 'official' discourses of his analyses. But in his reconceptualising Foucault makes clear that these fashionings are not to be seen as representative of any direct connection between individual action and social structure that holds true for *all* individuals in any system of governing. Nor is it to suggest that a causal link cannot be made whatsoever. It is more an issue of specificity. The patterns found in a culture which are proposed, suggested and imposed on an individual by her culture, her society, and her social group are to be seen as situated at the level of her daily practices. Each type of authority derives from its own specific set of social forces and power relations in the way it produces, regulates, surveys and labels its activities, according to its own ensemble of rules. The pedagogical relation, for example, has its own background of specific historical practices. It also has its own logic even as it is located within wider sources of domination. In this relation teacher authority to which the student is complicit is subsumed by more global structures *but is never reduced to them* (Walshaw, 1999).

## Towards a Progressive Politics

Foucault's final work provides us with the possibility of finding a new impetus for "the undefined work of freedom" (Foucault, 1984a, p46). He turns his previous work upon itself and in this way is able to offer a counter-argument to criticism that might be, at that time, or in the future, levelled at him (for example, the critique of Fraser, 1989). He offers a modem ethics of the self infused with an emancipatory potential. Indeed it cannot in any way be said to be politically pessimistic with regard to interventional possibilities because Foucault himself states that its aim is to "promote new forms of subjectivity through the refusal of [a] kind of individuality which has been imposed on us for several centuries" (Foucault, in Dreyfus and Rabinow, 1982, p217). Foucault argues that the more conventional idealistic and materialistic analyses offer no scope for emancipatory practice[5] and suggests that his work on the *ethics of the self* offers a way of

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[5]    Foucault (1991) argues against the possibility of calling a politics 'progressive' if it is based on a nebulous idealism that gives primacy to a free-ranging and unconstrained human consciousness. In that

circumventing the difficulties encountered within these earlier analyses. His argument is that a progressive politics might best be served not through adherence to externally imposed moral obligations, but rather upon an ethic of who we are to be, and what, therefore, it is possible for us to become. That is, through the formation of a critical ontology of the self.

What is of major importance is that Foucault formulates his modern 'ethics of the self' around a set of terms expressly borrowed from Enlightenment thought. The significance rests on the realisation that Foucault is ordinarily considered an '*anti*-Enlightenment' thinker. Foucault justifies this unexpected turn in his important essay *What is Enlightenment?* written towards the end of his life and published in "The Foucault Reader" (1984). It is in this work that he clarifies his indebtedness of the philosophy of the Enlightenment and his desire to interpret it for a critical ethos relevant for contemporary life. This he undertakes in his investigation of Ancient Roman and Greek moral practices in the second and third volumes of "The History of Sexuality".

Central to his rereading is the Enlightenment notion of critique. Indeed it can be seen that in moving his work from the strategic practice of *criticism* to the idea of some *regulative truth* and to the concomitant idea of *critique as its enabling condition* that Foucault is able to form the basis of his modern ethics of the self. To be specific, Foucault formulates his ethics around a non-essentialist notion of identity, and thus reworks the Enlightenment concept of autonomy beyond a purely descriptive categorical device. In its redefinition autonomy is linked to a notion of political resistance or opposition, a questioning of what appears as natural and inevitable about one's identity. By making this connection Foucault is able to theorise autonomy as coextensive with the development of a theory of resistance - an 'ethics of the self' - or what he calls a 'modern ethics'. Thus autonomy is necessary to a state of positive liberty, in which the individual exercises critical judgment of dominant beliefs.

In this new definition autonomy assumes an analytic function through which to explore the way in which people act in modern society and give meaning to their experiences and activities. That is, it looks closely at technologies (or practices) of the self - those rules of conduct the individual sets herself intentionally and voluntarily. Thus, the idea of autonomy becomes intimately linked with the idea of technologies of the self. And it is by formulating autonomy in this way that Foucault is able to marry the critical investigation

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politics, he argues, each and every gateway to change and intervention is open. He questions too how a progressive politics could be served by materialistic analysis.

of the individual's socio-cultural situation with a capacity for self-governance. Blake and his colleagues (1998) elaborate:

> It is because she has no essence that the subject enjoys...a freedom of fragmentation: A freedom that arises in the constellation of differences that constitute a lineage of loose alliances, relations of resistance and mastery, and configurations of fluid interests. The freedom of fragmentation remains real in response to the constant transformation of problems. It puts in question the firmest of principles and established practices. The result is an ethic of responsibility for the truths one speaks, for the political strategies which these inform, and for those ways of relating to ourselves that make us either conformists or dissidents. For Foucault ethics involves understanding oneself as the subject of a critical practice of freedom which is not outside the games of truth. (p 62)

In his ethics of the modern self Foucault also names these practices as an 'aesthetics of existence', and in this rewording we are drawn to the attention of the self as never pre-given, but as a 'work of art'. That is to say that one constitutes oneself continually as a work of art. Indeed one is obliged to do so, ever mindful of limits: "modern man...is not the man who goes off to discover himself...; he is the man who tries to invent himself. Thus modernity...compels him to face the task of producing himself" (Foucault, 1984a, p42). What the idea of 'limit attitude' entails for the individual is an appreciation of what she is or is no longer able to surrender in order to constitute herself as an autonomous subject. As Foucault sees it, what she might become stands as the political, ethical, social, and philosophical problem of today. If she shuns the responsibility of authentic self-creation she comes to be entirely fabricated by others. She cannot simply, wilfully fashion a new self, as Waugh (1992) has argued, but she can use aesthetic strategies to reformulate available resources.

In aligning the idea of the 'limit attitude' with the notion of 'work of art' Foucault is able to shut down any discussion that the individual constructs herself as a girl in mathematics without regard to her culture. Furthermore, the idea of choice on which such disregard and self-construction relies suggests that the girl is able to occupy a position outside of gender in order to choose a gender. This is the 'disembodied' notion of agency against which Butler (1987, p128) forcefully argues[6]. Butler stresses that choosing one's gender is a process which is not wholly conscious but nevertheless accessible to consciousness. It involves the interpretation of a cultural reality which is weighted with sanctions, taboos and prescriptions. For Butler gender is based on a notion of the body as a double 'situation'. On the one hand the body is both the locus of cultural interpretations, that is, it is always already caught up and defined within a social context. On the other hand the

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[6]     Butler (1987) argues: "gender is not traceable to a definable origin because it itself is an originating activity incessantly taking place. No longer understood as a product of cultural and psychic relations long past, gender is a contemporary way of organising past and future cultural norms, a way of situating oneself in and through those norms, an active style of living one's body in the world" (p131).

body is also the site at which the individual is required to receive and actively interpret that set of interpretations:

> As a field of interpretive possibilities, the body is a locus of the dialectical process of interpreting anew a historical set of interpretations which have already informed corporeal style. The body becomes a peculiar nexus of culture and choice, and 'existing' one's body becomes a personal way of taking up and reinterpreting received gender norms. (Butler, 1987, p133-4)

Precisely because Foucault formulates his ethics around a non-essentialist conception of identity which Butler proposes, and around a reworking of the Enlightenment concept of autonomy, he is able to map the way to overcome some of the difficulties in certain existing emancipatory work in mathematics education. Ultimately it offers current work in the field the challenge of thinking through sexual difference. It has major implications for girls in school mathematics because what Foucault is suggesting is that one of our most urgent present-day political struggles lies in the constitution of one's identity within contemporary regulated forms of subjection. The question that becomes paramount is how can the growth of capabilities be disconnected from the intensification of power relations? This leads to a consideration of how the girl herself comes to an understanding of the elasticity of her current individual freedom by constantly exploring the limits of her subjectivity. It is to concede that she does this, in the first instance, by questioning the boundaries of the taken-for-granted understandings of girls in school mathematics and revealing how these established forms of identity are necessarily contingent and historically specific. At this point the possibility of transgressing the so-called limits is made available and this too is the point where the potential for new forms of subjective experience is established.

Foucault differentiates between socially imposed 'ethics' and internally constructed 'morals'. As McNay (1994) argues, he does this by making a distinction between the imposed 'prescriptions' of moral codes that determine which acts are permitted or forbidden, which acts are ascribed positive or negative valence in a constellation of possible behaviours, and the ways and means by which individuals constitute themselves as the moral subjects of their own actions. It is those latter actions that are situated at the level of an individual's daily practices which need to be examined because they reveal the different ways in which one's self is formed as an ethical subject. Foucault (1988b) argues that one should consider all of the practices as a whole that "constitute, define, organize, instrumentalize the strategies which individuals in their liberty can have in regard to each other" (p19). What he is interested in are those games of truth and error which are played in the constitution of ethical subjectivity:

> ...The games of truth and error through which being is historically constituted as experience; that is, as something that can and must be thought. What are the games of truth by which man proposes to think his own nature when he perceives himself to

be mad; when he considers himself to be ill; when he conceives of himself as a living, speaking, labouring being. (Foucault, 1984c, pp6-7)

However it would be incorrect to suggest that an in-depth large-scale *social* analysis is implicit from a consideration of practices of the self suggested to or imposed upon *individual* girls in schooling. The importance of these specific practices lies in their ability to lay bare the areas of dissent, resistance and efforts at change that exist amongst girls within the educational apparatus. The ways in which individuals respond to the socio-cultural determinants is never straightforward and in order to capture the dynamic and positive aspects of power it is essential to examine those intentional and voluntary actions by which they not only set themselves rules of conduct, but also seek to transform themselves; to change themselves. This suggestion of a more active notion of how girls assume their gender identity within school mathematics provides a challenge to fundamental assumptions about the powerlessness of women.

Thus a consideration of the girl of school mathematics within the pedagogical relation would express her subjectivity and her autonomy in anti-essentialist terms in such a way as to avoid any suggestion that her agency might unearth an authentic 'natural' self. Her aesthetic self-fashioning is not oriented towards the recovery of an essential inner identity but towards an exploration of the scope for potential and ways of existing in the world. I am suggesting that the girl creates herself in daily school life as a 'work of art'. By this I am referring to those involuntary and intentional self-imposed rules by which girls conduct themselves. In Foucault's words, these are the rules by which they also "seek to transform themselves, to change themselves in their singular being, and to make their life into an oeuvre that carries certain aesthetic values and meets certain stylistic criteria" (Foucault, 1984b, pp10-11). It is based on a principle of self-critique that is experimental, endless, and relinquishes any hope of attaining a complete and definitive knowledge of what may constitute our historical limits. She is neither the origin of the particular teaching/learning arrangement in which she finds herself, but neither is she a passive member of it, or of the wider education system. It is a more a matter of mutual dependence of structure and agency in a dynamic configuration. To be sure her seemingly diverse and conflicting activities are necessarily curtailed, but they can never be contained once and for all. It is she who, together with the teacher, has constituted this relation and it is they who simultaneously are its very medium. She has the capacity to modify the relation even as it shapes her.

> I...believe that there is no sovereign founding subject, a universal form of subject to be found everywhere. I am very sceptical of this view of the subject...I believe, on the contrary, that the subject is constituted through practices of subjection, or, in a more autonomous way, through practices of liberation, of liberty. (Foucault, 1988c, p50)

## Conclusion

There are certainties which postmodern thinking challenges and the theoretical rationale for this questioning can be found in poststructural modes of social and cultural analysis. The challenge of poststructuralist thinking, like that of Foucault's, is that theory becomes grounded not in absolute truth claims, but in the politics of historically specific situations. Its usefulness is more usually evaluated in terms of the effectiveness of its deconstructive critique of how power functions in particular instances. But I believe that it should do more than this. It should also be able to create a politically constructive moment. In this regard I have argued that Foucault's final project has far-reaching implications for work on girls' subjectivity. The political possibilities centre on the individual as both the site for a range of possible forms of subjectivity, and subjected at any particular moment of thought or speech, to the regime of meaning of a particular discourse but which enables her to act. What Foucault's final work makes possible is a politics which embraces a recognition of the multiple and contradictory aspects of both our individual and collective beings.

From the perspective of interventionary work in the field of gender in mathematics education, a whole new space for critical reflection on the scope and limits of freedom becomes available. What presents is the possibility of moving beyond one's current self, and what one might be doing or thinking. In other words, Foucault's theorising provides the conceptual tools for a project of freedom, of going beyond the 'limits' that are a making of one's own particular historical situation and circumstances. It enables us to grasp points where change is possible and desirable, and determines the precise form this change should take. It gives new direction to the undefined work of freedom to be achieved by working at the limits that have been imposed on us.

For the work at hand, it is not a question of ascertaining the truth about girls in schooling. In Foucauldian approaches, human nature is not a hidden essence waiting to be discovered, but rather an artefact, an aggregation of those available forms the girl in mathematics must choose to shape into coherent identity. Foucault's theorising enables us to understand the implications for girls of different versions of femaleness in school mathematics within a specific educational environment. It asks: What formative events have brought this present situation about? How are girls in mathematics constituted as subjects of their own knowledge? How are they constituted as subjects who exercise or submit to power relations? How are they constituted as moral subjects of our own actions? In this slippage from taken-for-granted truths about girls in school mathematics, the question of validity arises. However when all is said and done, judgments about the validity or degree of effectivity of Foucault's theories must, of necessity, focus on their

effects. In the final analysis the progressive politics which Foucault points towards must be judged by the social practices that it legitimates.

## CHAPTER FIVE:

## 'Truth' as a Production
## or
## A method for the conduct of research in the postmodern

> Truth isn't outside power, or lacking in power: contrary to a myth whose history and functions would repay further study, truth isn't the reward of free spirits, the child of protracted solitude, nor the privilege of those who have succeeded in liberating themselves. Truth is a thing of this world: it is produced only by virtue of multiple forms of constraint. And it induces regular effects of power. (Foucault, 1984a, p72-3)

### Introduction

Any educational piece of research sits at the conjunction of the worlds of ideas, of practice and of communication. It is the task of the researcher to bring these worlds together. However my move into the world of postmodern ideas now presents a challenge to the traditions of research legitimacy that more often than not serve as the normative basis for contemporary mathematics educational critique. In light of the preceding discussion of Foucault's work the apparently simple question "what do we know about girls in school mathematics?" now becomes much more complex in its exploration. Central to the question is the problem of whether the critique that Foucault has levelled at the notion of the individual and of knowledge itself, and whether his understandings can serve as a basis for the practice of research in mathematics education. Moreover, it is not clear whether these can be put to use as a tool of emancipation, pursuing and sustaining a progressive politics of girls in schooling.

In this chapter I set out my research method and give an account of the conditions which contributed to how the method came to be organised. This requires some level of advocacy on my part for advancing a more inclusive and a wider definition of research, which takes into account Foucauldian notions of the subject that can be drawn upon for girls in school mathematics. Fundamental to this agenda is the presumption that Foucault's ideas can indeed be reworked to escape the limitations of what is deemed acceptable for mathematics education and, beyond that, for more general social and educational research. Accordingly, I provide a model of educational method which, I believe, directly engages both the concern for interrogating the notion of subjective experience and meaning while simultaneously providing possibilities for change.

## The Research Question

Historically, philosophical scholarship in mathematics education has always articulated a social vision for the discipline. In the context of the research practice it has been relatively clear in the past what needed to be done and what methods to use, as there has been more or less agreement, at least in the Western world over the aims of mathematics education (cf Sierpinska and Kilpatrick, 1998). However within the last three decades the field has become more openly interdisciplinary (Ernest, 1998), drawing upon and often importing the concerns of both the sciences and social sciences, the humanities and other domains of professional knowledge. The effect has been to disestablish the community into specialised groups each with its own research interests and aims. In this context I felt free to journey beyond the divided realms of mathematics education for ideas to the thinking of Foucault.

*How are girls constituted and how do they constitute themselves as gendered subjects in the secondary school mathematics classroom?*

This is the question around which this piece of research is centred. Foucault provided the conceptual resources for the research question to be formulated in this way by forcing me to look at and think about the gendered subject in mathematics education differently. There were other conceptualisations of the 'girl' in schooling that were available to me through the work of the liberal feminists and the reconstructionists as we have already seen. Though diverse in their orientations, both have contributed to an understanding of the girl in school mathematics. Their important work not only provides clarification and critique, but also offers alternatives. I could have drawn on these understandings but they would have undermined my original intentions by reducing the phenomena of the 'girl' to a rational fixed core or essence and/or would have trivialised gender. I considered that they would not have dealt adequately with the girl in school mathematics.

The question responds to a key concern of mathematics educational policy, practice and research in postmodern cultural and economic conditions: the question of how gendered difference in subjectivity is routinely formed within the institutionalised practice of schooling. I want to look at the relation of the schoolgirl to mathematics by interrogating both 'authoritative' presentations and girls' own engagement with mathematics. This will enable me to examine the place of school mathematics in the making of feminine subjectivity, in this case, the subjectivity of adolescent girls in the mathematics classroom. In doing this I am claiming that subjectivity is produced at the intersection of a number of often competing discourses and practices all of which position and designate the girl in school mathematics.

## Educational Research in the Postmodern

This work is a feminist project situated within Foucauldian theoretical tenets. The details of the research design around which I have organised it are specific to the political possibilities of the 'girl in school mathematics'. But here I want to delay a discussion of how I proceeded in order to respond to a prior question that needs addressing. Having located the research question within poststructuralist ideas the problem that now surfaces concerns the implications of poststructuralist thought for the undertaking of this investigation. Since poststructuralism does not stipulate method what I need to discuss before all else is what it means to do research in a postfoundational era and the conditions that contributed to the decisions that I made for my method. More specifically, what needs to be considered are the implications of the postmodern suspension of all claims to truth and all forms of value judgment for a research project in mathematics education.

Those who claim allegiance to postmodernism would unanimously concede that educational research can no longer maintain its 'rightful' place as true and absolute. This is so because what the poststructuralist critique of the foundations, the function and the status of scientific knowledge, does to research is to denaturalise science's transparency, reducing it to a context bound textual production. Without a doubt this is profoundly unsettling to the researcher who is forced to rethink research practice and its legitimation. What she confronts is a world where the 'real' is no longer self-evident, a world where, as Fay (1996) has suggested, understanding others, particularly others who are different, might not be possible at all.

To attempt to reconfigure research that engages with contemporary academic debates and theoretical discourse is not an easy task. Currently many postmodern thinkers, ranging from literary and social philosophers to political theorists who have enthusiastically taken on board the philosophical lessons of the poststructuralist attack on traditional forms of thought and orthodox notions of rationality and the unified subject, appear to be grappling with the problem of method and lack of resolution. I do not intend to recirculate the divisions of their debate. Suffice it is to say that each has sought to expand beyond the conventional patterns of Western scientific method to produce work which abandons belief in science as truth and also in the expectation of attaining universal criteria of judgment. Their projects move research beyond the structuring regulations of the true and the false, the objective and the subjective, and the valid and the invalid to draw on a different set of strategies, protocols and conventions. Unfortunately their work is at times characterised by an intellectual elitism and a level of abstraction far removed from what most mathematics educational researchers would wish to entertain.

But if we were prepared to put this elitism aside, what we would see as emergent in this new research endeavour are evocative portraits, a type of data reporting that, as the poststructuralist anthropologist Marcus (quoted in Lather, 1991) claims "emphasizes a direct exposure of other 'voices'...unassimilated to given concepts, theories, and analytic frames" (p13). This is an unmediated data display, a break with the notion of 'researcher authority' as 'mastery over'. Lather (1991) offers the metaphor of a web of contradictions, of ambiguity and of complexity, to describe the refusal to tell 'tidy' narratives which conform to cohesion. To be sure these analyses, with their stress on the plurality and constant deferral of meaning and precarious subjectivity, are helpful moves beyond a critique which attempts to identify one true and universal meaning. Nevertheless I am mindful of oppositional arguments put forward by others such as Constas (1998), who contends: "one may be left with the sense that the discourse of postmodernism has done little more than create a playground for frustrated poets who offer us their musings about the disintegration of knowledge" (p27).

For me, the role of research is not to nurture subjective worlds. Deconstructive approaches to educational analyses which share a disregard for the wider historically specific discursive context of education and the power relations which structure the mathematics educational field do not meet the aims of this work. However, the problem of how to demonstrate a new form of research legitimacy remains unresolved. But what I want to suggest here is that it should be possible for poststructuralist research in mathematics education to create *constructive* as well as deconstructive analyses. What this new research practice will entail will have much to do with thinking outside of customary practice, of border lines and framing the meaning of reality and how we come to know it. But what inheres in the notion of the border line is a paradox: where do I draw the line? How far can I draw on poststructuralist thought for the doing of educational research? I want to 'draw the line' on poststructuralist fragmentation by reworking Foucauldian notions into the powerful currents of *conventional* research methods. My task is to mobilise aspects of Foucault's theorising *constructively* for a piece of empirical research.

## The Research Design

> To be able to see and describe the world as it is, you have to be ready to be always
> dealing with things that are complicated, confused, impure, uncertain, all of which
> runs counter to the usual idea of intellectual rigour. (Bourdieu, 1991)

The research design which I have employed to conceive and resolve the research problem works at the edges of what is currently available in mathematics education. It is ever mindful of the poststructuralists' claim that representation is always in crisis. What this requires of me is not a tactical avoidance of representation *per se,* but a recognition on my part that representation in its 'purest' and most 'truthful' forms is unattainable. Although

the concept of absolute and true representation might be theoretically redundant, as researcher I can *never avoid* representation. This realisation of the inescapability of representation is not to suggest that I stand on or act out of nothing. Nor is it to anticipate the end of the production of valid, rigorous research that opens itself up to public scrutiny (Lather, 1991). Rather, as I take on board these understandings, my responsibility as researcher, shifts away from working towards representations of the Truth, to declarations of the limits of my structuring practices in representing others.

Accordingly I will clarify why I have valorised a particular research design and discounted others. My method is neither neglectful of local practice nor is it irresolute. Its precise techniques have been chosen with a certain deliberation as the means by which my understanding and interpretation of school life will be encoded. I do not consider these techniques an impediment to the research, but necessary imperatives for my representations of what I see and hear. If I am to make some sense out of texts and classroom experiences and make these accessible to others I will need to stage and organise my representations of them. However in doing so I am well aware that the way in which I reconstitute the classroom world of girls' mathematical experiences relies upon my access into the connections and engenderings of these experiences. And although my reconstruction of these experiences presents as a self-contained whole, it is inevitably tangled with the complex issues of economy and power.

From the beginning of the research I was committed to understanding the ways in which gender is a social production, and how it might be implicated in the apparatus of our educational institutions. And since I believed that if a study on girls in school mathematics is to have strategic applications in the wider social field then it will need *both* philosophical scholarship and field work. That is, it will be necessary for me to go into the school itself to search for these girls in school mathematics who exceed our current categories. My particular interest is in the way in which forms of power within the classroom and the texts it draws upon, constitute the girl in secondary school mathematics, and in the ways the production of knowledge is controlled and contested. I want to analyse the process by which these relations of power penetrate the complex workings of the classroom to produce subject positions. I want to see how these subject positions in their contradiction and multiplicity are lived. Through this analysis I hoped to reveal how the girl enters into a certain notion of truth about what it means to be a female student of school mathematics. My expectation is that if I can illuminate those practices which cause girls to be what they are in the mathematics classroom, I can also identify where, both the girls themselves, together with feminist interventionists either within the classroom or at the wider policy level, might "grasp the points where change is possible

and desirable and [be able] to determine the precise form ...change should take"
(Foucault, 1984a, p46).

My search for a method to resolve the research problem was not straightforward.
Notwithstanding Foucault's formidable accomplishments in the important world of ideas
which I found useful to articulate alternative ways of thinking about gender, his exacting
scholarship does not tell us how to put his theory to work. There were many possible
designs which I could have made use of but most would not have been productive for my
project. The method upon which I settled revolves around Foucault's notion of
subjectivity. As we have seen in the previous chapter, Foucault theorises subjectivity as
discursively constructed and it is this notion which provides an important way of thinking
differently and perhaps more creatively about the politics of the contextual construction of
social meanings. The idea of discourse[1] as constitutive - as contributing to the
production, transformation and reproduction of the 'girl' of school mathematics - opens
up a way for me to engage with the category 'girl' yet not be reduced to its essentialism.
Foucault would insist that the 'real' world of girls in mathematics can only be known
through discourses. Simultaneously however Foucault's notion of subjectivity argues for
the production of a theory of subjectivity as having application in a localised 'history of
the present'. For my work this would entail the development of a theory of the female-
embodied girls in school mathematics that is based on its specific, emergent and
conflictual history.

## Reopening Discourse

It is the notion of the discursive construction of subjectivity that will guide me in the
theory's development. It suggests that the data for my project might be generated from
exploring the *discursive* practices at the micro-level which constitute the girl in schooling.
It is useful to recall at this point that a discourse is an historically, socially and
institutionally specific structure of statements, terms and categories involving knowledge
or validity claims. Discourses mark out identifiable systems of meaning and fields of
knowing and belief and it is through them that subjectivities are strategically fashioned
and contested in the dynamics of everyday life. Particular discourses of girls in school
mathematics in New Zealand society are founded in the educational enterprise and in the
social, economic and political organisation of the family and of the workplace. Whether in

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[1]     The term 'discourse' gives rise to two other terms which are related: discourses   exist in
'discursive fields' which gives rise to 'discursive formations' or groups of regulated practices. A
'discursive event', according to Luke (1995-6) is a boundaried instance of social interaction around or with
a written or spoken text.

spoken, written or electronic texts[2], discourses are connected to a wider network of power relations which make possible particular articulations of girls in school mathematics and regulate social practices about these understandings. If, for example, the girl of school mathematics is observed and regulated as 'irrational' and 'emotional', it is because a set of critical pathways is forged between a number of distinct elements, some of which concern the status of mathematics, the status of female learners, and the institutional sites from which these elements originate.

These discourses from different sources, embodying varying interests, offer the girls in my project preferred forms of subjectivity. In the classroom, in the family and in the other social fields in which she leads her life discourses construct her self-understandings - the meaning of the 'nature' of her physical body, her unconscious and conscious mind, her emotions and desires and what it means to be a girl in school mathematics. Discourses are centrally bound to the way in which she organises her meanings. In the classroom she comes to know the regular and predictable generic[3] forms of discourse associated with particular activities. She comes to know what is considered 'normal' and 'natural' and how to recognise categories of gender identity. Her subjectivity becomes the locus of consensual regulation - a regulation which is complete when she identifies with the particular subject position of the constituting discourses.

In the Foucauldian approach, the 'girl in school mathematics' can only be read through the notion of discourse. She *is* the production of the practices through which she becomes subjected. This idea is important because it suggests practices of disciplining and regulation which are, simultaneously, practices for the formation of her as a subject in school mathematics. It also suggests that the girl in school mathematics can never be fully reduced to these practices. For Foucault the production of the girl has to be understood in relation to her historical formation and its effectivity. She needs interaction with others and their discourses in order to form a self concept. The very possibility of forming and articulating concepts of one's self and the world one knows is ultimately dependent on the linguistic practices used in everyday life. If meaningful experience is constituted by rather

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[2]     Halliday (1985) defines 'text' as language in use, that is, any instance of written and spoken language that has coherence and coded meanings. The individual cannot avoid engagement at any single moment with texts of some form or another. Constrained within the 'text', and bounded by institutional location and its procedures, rules and regulating practices are to be found 'discourse events'. These mark instances of social interaction around or with a spoken or written text.

[3]     As an example of genre, the New Zealand secondary school mathematics exercise book is a highly conventional educational genre. It was historically developed to record the in-class and homework written efforts of the student. It has some predictable and characteristic textual forms and textual, specifically, small page area, grid lines, bounded pages, front-cover space allowance for student's name. Local practice often demands that students draw a single vertical line down the middle of each page to enable work to proceed down the two columns in turn.

than reflected in language then the meanings that girls produce in accounts of their experiences and themselves are only available through language. The sense they have of themselves and of their social relationships is determined by the flux of meanings in discourse that occurs outside themselves. The only meanings available to the girl are those attuned to the things both said to her and, importantly, said about her. As Blake and his colleagues (1998) have argued, no subject could construct a set of meanings derived wholly from her own experiences without recourse to the language and meanings of other people.

However this is not to suggest that the girl as constituted by discourse is trapped within some coherent but unwieldy metaphysical framework. Language is not monolithic; it generates different versions of experience. How the girl re-presents discourses and uses them to formulate and articulate her own version of the world and of herself varies from one occasion to another. Meanings that she generates can never be warranted as stable since they transform, as different assumptions, contingent on contextual and local factors, are brought to bear (Weedon, 1987). What can be stated with certainty is that the discursive constitution of subjectivity never remains constant. In negotiating everyday school life girls will assume various positions in discourses which offer possibilities for difference. It is an ever-changing process, linked to the realm of relationships, and one which begins at birth and is repeated continually throughout school life as discourses make themselves available for constant renewal. In short, meanings both reproduce subjectivities and have the capacity to modify them.

## Language

My ultimate concern is to apply Foucault's theory of the relation between meaning and subjectivity. If we understand subjectivity to be a complex constellation of processes then to understand the subject involves a consideration of the processes that constitute the subject. Thinking of subjects as produced by processes which are at once material and discursive points to a method that can identify precisely the specific practices and mechanisms through which a personal classroom subject position is created for each individual participant in the study. To investigate the subject then suggests a focus on the site where meaningful experience is constituted and where possibilities for change are determined, namely, in language. Language provides a way of understanding how conventional meanings of girls in schooling are both established and currently experienced. By paying close attention to language use I want to demonstrate how language functions to actualise gender and power relations within various texts. Without attention to language and the processes by which meanings and categories are constituted, I could only impose an oversimplified model on the lifeworld of the schoolgirl - a model

that perpetuates conventional understandings rather than opens up new interpretive possibilities.

It is my contention that the meanings generated within the school from the creation of the subject position 'female learner of school mathematics' are produced and reproduced as a social fact by subtle yet pervasive exercises of power relations in the classroom. I am interested to see how these instances of local classroom discourse connect to broader heterogeneous forms of power governing social relations, namely, political, economic and cultural formations. The methodological significance of taking on board Foucault's notions of power and subjectivity is to attempt to identify the processes by which the girl in school mathematics is constructed as an gendered object of knowledge. But it is not solely the status of *subjectivity* which motivates my investigation; my interest is also with the position of *agency* and dissenting discursive practices. Foucault argues that if one is to arrive at an adequate understanding of the modern subject, a two-fold approach must be adopted in which an analysis of techniques of domination [sometimes referred to as technologies of subjectification] are to be juxtaposed with an analysis of techniques of the self. In other words a consideration of how the subject is constructed as an object of knowledge needs to be matched with an analysis of how the individual comes to understand herself as a subject and the forms of self-government she employs.

This is a directive for my work in that it suggests how one might analyse power differentials that exist between and amongst girls. The suggestion points to an examination of the various techniques of the self which are employed to order their lives and by which they exert influence on other individuals. This is a more productive model of the modern subject than in existing mathematics educational analyses in that it makes provision for agency and self-determination in the way in which individual girls act, especially in the ordering of their every-day school existence. By elaborating the interaction between the two separate techniques my analysis will be able to make this autonomous action apparent. The analytic process itself leads to a more rounded appreciation of the relationship between the individual agent and social structures.

## Generating data

I chose to examine the way in which the girl is constituted and how she constitutes herself as a gendered student in mathematics at two different levels. The data is drawn from: a) the written text of the official school mathematics curriculum policy document for New Zealand schools, and, b) spoken texts taken from a mathematics classroom. Whilst the data from the policy document was in a very real sense already generated, the data from

the classroom needed to be sourced. The decision of which techniques to employ to do this was guided by Foucault's insistence of the importance of discourse in the construction of the subject. The final focus emerged after I had read the important educational work of Alton-Lee and Nuthall (1991) and their development of a technique of 'private talk recording'. My understanding, derived from Foucault, was that private talk and conversations, as two of the most pervasive uses of language, may have an important influence on the ways in which people grasp themselves and their relation to the real situations in which they live.

I was granted approval to undertake this investigation within the classroom from the Ethics Committee at the university and duly 'piloted' the method of 'private talk' in the sense that I tried it out on a number of students in the class of 29 students during a preliminary calculus lesson. The tape recorder did not seem to inhibit the lesson and appeared to provide a wealth of data of a rather unique kind. I settled on the method of 'private talk' and used the data which was generated from it, together with the girls' private talks with me, the field notes that I took from my classroom observations, and students' photocopied work, to compile my bank of data. By collecting data from a variety of sources it was possible, as Atkinson (1995) and Delamont (1992), among others, argue, to build up a much more robust understanding of the way girls constructed meanings of their social world. I used all the sources of data for the analyses of subjectification, and the analyses of techniques of the self.

In consultation with the class teacher three case-study students were selected from those 13 who had parental permission, who were keen to participate and who were reasonably articulate, but not all necessarily high achievers. I wanted to explore the talk which took place in three distinct groupings within the classroom and this condition also factored into my final choice of three students. At the beginning of each calculus lesson the students clipped a small microphone onto a piece of outer clothing and placed the small transmitter on the desk. They had been familiarised previously with the recording equipment and knew how to turn off the recording if at any time they wished to maintain the privacy of their conversations. These individual microphones were used to record teacher talk and both the private and public talk of the three students during the course of the lessons. Continuous recordings were made for the entire block of work on calculus, of both loud and inaudible private conversations both between students, and between teacher and student, and of the whispers and mumblings that students made to themselves. Gradually these developed into the series of three 'dialogues' from which the material used in the analysis chapters following is drawn.

The girls' talks with me took place at a time convenient to each individual student. Each interview was audio-taped. The questions I asked were reasonably unstructured so that the students could explore in a searching and insightful way ideas about themselves in mathematics and their relations with others both in the classroom and the wider social fields to which they belonged. In this sense the technique that I employed could more appropriately be called here 'conversations'. It was not a difficult process for either the students or for me because the students were very keen to talk. The point of carrying out the conversations was to unpack the meanings that the girl herself attached to her individual construction as a 'girl in school mathematics' as she traced the path of her individual constitution. Given the theoretical primacy of 'talk' itself and the focus on how talk is constructed and what it achieves, consistency between the girls' responses was not sought. I wanted to know what formative events and conditions had contributed to her present situation, how she constituted herself currently as a girl in mathematics and how she constituted herself as a moral subject responsible for her own actions.

## Analysis of data

> We should try to discover how it is that subjects are gradually, progressively, really and materially constituted through a multiplicity of organisms, forces, energies, materials, desires, thoughts, etc. (Foucault, 1980, p97)

Systematic collection of data is fundamental to my project of developing a theory of girls in mathematics. It is also necessary if I hope to be able to advance a more general theory of girls in mathematics. But reporting this data by way of simply 'giving voice' to the girls is not enough. If this project is to offer suggestions related to practical transformation then it must *make accessible to others* those networkings of experiential possibilities that constitute features of girls' subjectivity in school mathematics. Girls' self-representations must be incorporated into other kinds of evidence and perspectives if they are to be consequential in the public and political arenas outside the halls of the academy. Interconnections cannot be read off from general theory; they have to be established through analysis.

If this research project hopes to engage with the realities of the mathematical world of girls and make these realities intelligible to others it will need analytic tools in order to proceed. Some system of categorisation needs to be operationalised for describing the social relationships that constitute and govern female learners and for demonstrating the effect and the role which discourse plays in this constitution and government. Fundamental to the system I chose is the scholarly work of Foucault, but my procedure deviates from most of the recent educational analyses that find their inspiration in

Foucault. These analyses operationalise Foucauldian concepts more broadly[4] in order to establish an interpretive analytic design. But I turned Foucault's concept of subjectivity away from the endeavour of a 'macroanalysis' and into a 'micro' approach. If subjectivity is constructed by discourse, then it is dynamic, non-unitary and localised but moreover *discoverable only within intersubjective relations.*

The method I have used systematically examines classroom discourse as moments of intersubjectivity in a very localised site. This method, known as discourse analysis, is developed from both the work of Foucault and from linguistics and serves as an organiser for the analysis of my data. My particular orientation is towards *critical discourse analysis*, and is derived from the foundational work of Fairclough (1992, 1995). Critical discourse analysis begins in Foucault's theory of language and social power and takes seriously the plurality and constant deferral of meaning and the discursive construction of subjectivity. By reworking these ideas into a *linguistically*-oriented analysis which examines grammatical features of texts as distinctive social actions, it is able to pay *detailed* attention to the institutional effects of discourse and its role in the constitution and government of individual subjects. It is 'critical' in that it draws on Foucault's *later* understandings of the subject as an active participant in power contestations and able to contribute to progressive educational change.

The method of discourse analysis appealed in the first place because of its practicality. It is practical in the sense that it deals with naturally occurring talk and textual formations, and provides a readily usable categorical system for their analyses. Bearing in mind that all categories of analysis must be seen as provisional in that they are social constructs the meanings and consequences of which shift in different contexts, the categories which my model employs are those which I see as best depicting the social actors I seek to understand. Because the interest lies in interdiscursive relations the model organises its categories around the structuring or articulation of discursive formations within the classroom and the relationships between these formations. The approach is inductive, where induction is a normative analytic aim and principle rather than some kind of naively empiricist description of the research process. Unlike some other studies of discourse which are characterised by attention to the categories of textual form, structure and organisation at all levels, the process employed here amounts to examining the details of the texts as found, and tying analytic claims closely to those details.

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[4]    Examples of 'macro' ethnographic and case study approaches in educational research which draw on poststructural theoretical ideas are to be found in the work of Gore (1992), Lather (1991), Rhedding-Jones (1997), Singh (1993), and Wexler (1993). These researchers engage broad rather than detailed interpretive approaches for their thematically-inspired analysis.

Furthermore, my use of the method is not to be confused with discourse analytic methods in education that developed from the application of interactional sociolinguistics, ethnography of communication and ethnomethodology to the study of classroom talk[5]. In these approaches to linguistic analysis, Luke (1995-6) points out, the focus has ordinarily been on the study of language development and use per se. These approaches have tended to analyse language as a way of explaining the psychological intents, motivations, skills and competences of individuals. They subscribe to a referential relationship between language and reality; that is, they consider discourse and reality to be unambiguously and passively linked. Language is seen as a reference to objects which are taken to be given in reality so that when descriptions are made of the same event, action or belief, accounts will be generally consistent. Talk is seen to be transparent. Important though this work may be, it has significant shortcomings for my project in its narrow focus on recovering beliefs and cognitive processes from participants' discourses. In these approaches the issue of subjectivity tends to be marginalised by failing to give consideration to the ways in which discursive practices shape social identity.

In contrast, I am looking at the analytically prior question of how girls' accounts of their mathematical experiences are crafted. The point of my approach to discourse analysis is to find a way to analyse the written word, private talk and conversations that goes beyond a categorisation of 'transparent' speech acts. If words have no fixed or intrinsic meanings, then it seems clear that I need to determine how, in what specific contexts, among which specific communities of people, and by what textual and social processes meaning has been acquired. To engage with social and political issues of power in a dynamic and historically informed manner, I need to provide an analysis of the 'text' in terms of who is speaking, from what social position, in what context and with what political effects.

What I am interested in pursuing is to see how the various discursive resources which are made available to girls in these texts are organised and articulated; how they construct and regulate girls' subjectivities and social relations. In particular I want to explore how instances of coherent written and spoken languages drawn from policy documents and classroom dialogue operate with particular political interests to generate and sustain relations of domination and power in order to position these girls. My particular interest is in how texts articulate and embody particular forms of gendered difference, and how they construct and cultivate particular practices and positions for the girl in mathematics schooling. Clearly the claims to truth about the girl in school mathematics which these

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5      Luke (1995-6) notes the principal proponents of these applications to be Cazden, John, and Hymes (1972); Mehan (1979); and Sinclair and Coulthard (1975). Their work has in the main been focused on language, literacy and cultural differentials within the classroom and the educational effects of these variations for students from migrant, indigenous and minority groups.

texts embody are many and various but it is possible to draw links between their practices and their sets of assumptions about gendered difference.

My model studies the micropolitics of discourse. Its concern is with specifying the social effects of discourse, the sociohistorically variable 'discursive formations', systems of rules, which make it possible for certain statements and understandings but not others to occur at particular times, places and institutional locations. It considers how discourse systematically constitutes versions of the social and natural worlds and how girls are positioned by discourse in relations of power. Specifically it investigates how girls negotiate contestation and conflict in their self and world concepts and attempt to solve these dilemmas through language. In order to investigate these functions of discourse I have tried to identify relationships between individuals, social structures, and institutions using a process as outlined by MacNaughton (1998):

- Identifying how people are categorised, as formed and expressed in language.
- Identifying the social practices through which meanings are given to the categories.
- Identifying the patterns of emotional meanings and investments in particular categories.
- Naming the discourses that are formed by the categories, practices and emotional investments.
- Identifying the institutional basis of discourses that construct and are constructed in the classroom.
- Identifying the social power relations and effects of the different discourses that construct and are constructed in the classroom.

What is crucial for my work is that discourse analysis is able to map its categories onto a systematic analysis to reveal how discursive practice constitutes intersubjective relations of power by attempting to position, locate, define, regulate and enable those within the classroom. In other words it has the capacity to trace the way in which discourses create different material effects with regard to the construction of students' subjectivities. It is analytically powerful in the sense that it is able to capture a sense of the unspoken underlying what is spoken. It is, moreover, theoretically powerful as it seeks to contain the text in its very conditions of production and reception, constantly engaging theory and practice in a continuously self-informing process of inquiry.

## Placing the Researcher in the Process

In the following four chapters I begin systematically to explicate how texts represent the social and 'natural' world of girls in school mathematics. In chapter 2 I charted that

historical formation by looking at the emergence of categorisations of the girl in school mathematics and how these categories defined and regulated girls. In these next chapters by looking at the practices through which those designated 'girls in school mathematics' make sense of and live their everyday school lives, I want to build on those historically specific formations to try to understand the conditions of their current subjectification.

This unavoidably involves, on the part of the researcher, a construction of versions, informed in part, by constantly changing boundaries between discourses. It is, like all method[6], an unavoidably normative activity. This idea of all method as normalising behaviour is by no means insignificant in that it undermines a division between objectivity and subjectivity. Because this very notion underwrites my entire discussion in this chapter on the way in which I gathered evidence and on the theory and analysis of how I proceeded with the research, intertwining itself with issues of epistemology, I want here to consider it in more detail. My point in doing this is to argue against the notion that subjective intervention interferes with, biases, and distorts the real and truthful view of the object of study. I want to offer in the first place the argument advanced by others working with Foucault's ideas that it is an impossible, indeed an undesirable task to ignore the place of the subjective in research. Secondly, I want to suggest that if the subjective cannot be avoided then it is necessary to think about how the relationship between the researcher and her subject of inquiry might be factored into the research process.

Spoken discourse demands transcription, interpretation, and the subsequent writing of an ethnographic account. Written texts also require interpretation. What needs to be made clear is that the activity of transcribing private talk and interviews and their subsequent analysis is a process of meaning construction. As transcriber and analyst and as a producer of ethnographic accounts of the three girls in the classroom I need to make certain decisions about what exactly is said, and then represent my decisions in some conventional textual process. Britzman (1995) defines ethnography as "both a set of practices and a set of discourses" (p224). She argues that writing ethnography is "about constructing particular versions of truth, questioning how regimes of truth become neutralized as knowledge, and thus pushing the sensibilities of readers in new directions" (p231). The possibilities for interpretation are potentially limitless; a whole order of levels of different types of events exists, each with its own capacity to produce effects. As

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[6]    The idea of 'method' has always been, of necessity, normative. Carr (1997) traces the origins of the idea of 'method' to Greek philosophy. It originated as a means to organise the acquisition of knowledge in a way that was less demanding than philosophical theorising. Later, according to Carr, the intellectual, cultural and political currents of modernity established technical expertise, methodical conformity and ethical neutrality as central components to the idea of 'method' in educational research.

researcher I cannot avoid overlaying what I hear and see with my conscious and unconscious interpretive baggage, the interactions of which are complex and ambiguous. Much of what I ultimately decide counts as data inevitably is filtered by my own decisions about the relation of the spoken discourse to gendered subjectivity. In exactly the same way my field notes of events and practices in the classroom are but a personal documentation of what I see as being important at that particular moment to the theoretical questioning in which I was engaged.

In order to grasp the depth and extent of this argument for research one needs to be aware of the limitations of traditional analyses. In social scientific traditions, even those which utilise interpretive approaches, a move towards the subjective is a move towards the non-objective, the undesirable. Those within social science have traditionally felt that statistically analysed data in a quantitative form is more powerful and less open to problems of interpretation than data within which the subjective intrudes. Their approaches to validity and reliability use notions of detachment, intercoder reliability, triangulation and so on. But these notions are questionable in that they all imply some agreement, some place that transcends the subjectivity - the undesirable nonobjectivity - of the researcher.

Foucault is sceptical about the possibility of objective science. Emphasising the structures which antedate, create and exceed the methods of social science, he maintains that they are intrinsically conformist in that they buy into a battery of exclusions, privileges, and hierarchical privileging associated with metaphysical thought. Social scientific methods rarely question scientific normativity, least of all the value of objectivity of or objectification, which governs and authorises their discourse. Notwithstanding the methodological guarantees put in place to produce objectivity, the subjective will always intrude even in the most so-called rigorous research. It becomes impossible to ignore the subjective and brings to the fore the importance of questioning one's own position and its place in the analysis.

Harding (1987) notes that feminist analyses have responded by recognising that the cultural beliefs and behaviours of feminist researchers in no small way mould the results of their analyses. Revealing both methodological and epistemological features different from traditional ones they begin their analyses by placing themselves in the same critical plane as their overt subject matter, thereby recovering the entire research process for scrutiny in the results of the research. Thus researcher beliefs and behaviours are regarded as part of the empirical evidence for or against the claims advanced in the results of research. In this way the researcher appears in the analysis not as an invisible,

anonymous voice of authority, but as a real, historical individual with concrete and specific desires and interests.

But I believe the issue lies not so much in the taking on board or avoidance of one's own desires, interests and feelings, but in not taking them on board in a systematic way. I want to confront the issue from another angle by looking at what some might call the more esoteric concerns of research in the postmodern - the questions of voice, difference and power. In this study of girls in school mathematics I am interested in the production of subjectivity in the classroom and in understanding the place of school mathematics within this. I collect my data stories, mediated by my own researcher positioning, by looking, hearing and through informal discussions. I suggest that it might be more productive to make use of these different stories, rather than to try and 'rationalise' the differences between what I see and what I hear and what I am told. I believe that it is possible to develop a systematic methodology for the study of subjectivity and school mathematics which incorporates these issues in order to tell a more complex story. In doing so I am very much aware of the questionable status of the data with regard to its validity or reliability in traditional terms and also aware of the possible limitations to any larger claims I might make in the analysis. Probyn (1993) puts it this way:

> This task is to put oneself into the cultural landscape in order to throw it into relief and to allow new vectors and relationships to be seen, to be created. As 'man' fades away, the face of this discursive and effective landscape changes radically. Seen from the position of an alternative conception of the self, the self as an enunciative and theoretical strategy, this new landscape contains the possibility of ways of living within the social...of constructing theoretical accounts, and of experiencing oneself in relation to others in the historical present of oneself...In less heroic terms, Foucault's care of the self allows me to consider a way of speaking and of theorising that proceeds from 'me' without reifying me as the subject of my speaking. (p136)

## Conclusion

My search for a means of working towards a theory of subjectivity and a method adequate to the task is circumscribed by my theoretical interests. In this chapter I have argued that the resolution of my research problem be couched within Foucault's poststructural ideas - ideas that take seriously the instability of meaning and the precarious subject. But it was not simply a matter of arguing for a direct application of Foucault's ideas. I needed to operationalise his ideas about the constituting aspects of discourse and rework them within a critical linguistic analytical approach before I could hope to begin an investigation of the discursive construction of subjectivity.

My method of critical discourse analysis focuses on the organisation of discourse. It is, I believe, a model which directly engages both the concern for interrogating the notion of

subjective experience and meaning, inconsistent and incoherent though it may be, while simultaneously providing possibilities for change. It concerns itself with action, construction and variability. In these concerns, its agenda is two-fold. It has a deconstructive aspect in that it has the capacity to destabilise taken-for-granted authoritative notions of what is conventionally described as the 'personal' - for my project, the personal existence of a girl in the school mathematics classroom. In its constructive moment it seeks to activate agency among individual students and others by clarifying the possibilities for the redistribution of power and knowledge within the classroom. By laying bare relations of inequality, domination and subordination it is able to stimulate self-understanding, self-determination and action. It provides the opportunity to the students themselves to play a productive role in the transcendence of their present situation and offers possibilities for others working on behalf of the girls in schooling agenda.

## CHAPTER SIX

## Shaping up the girl

or

## Forms of subjectivity and the policy document

> The problem is at once to distinguish among events, to differentiate the networks and levels to which they belong, and to reconstitute the lines along which they are connected and engender one another. From this follows a refusal of analyses couched in terms of the symbolic field or the domain of signifying structures, and a recourse to analyses in terms of the genealogy of relations of force, strategic developments, and tactics. (Foucault, 1984a, p56)

### Introduction

This chapter marks the beginning of the analysis section in which I systematically explore how various discursive resources, which are made available to girls in a variety of texts and sites, are organised and articulated. The most official and authoritative form of dominant discursive practices in New Zealand mathematics classrooms is the current curriculum document "Mathematics in the New Zealand Curriculum". It acts as a mediator of the world of school mathematics for the reader, clarifying those social issues, problems and future interests which it identifies as in need of addressing through school mathematics. It is thus utopian and visionary. Through its official statements of mathematics, agendas are set, priorities are enforced, some categories of knowledge are naturalised and others are disqualified. It is in this sense that the official curriculum document can be reappraised as a set of institutionalised ideological practices related to real world contingencies. It is in this sense, then, that it functions as a cultural institution, endorsing particular constructions of gender.

In this chapter I want to look carefully at the national curriculum statement because the subjectivity of girls is implicated in the way that it has chosen to reveal its version of the world. I ask questions about what particular political and social order is made explicit. In asking this, my specific interest is in those ideological versions (Luke, 1995-6) of the world of girls in school mathematics which are constructed and the subjectivities which are demanded of them. I want to see how the girl is constituted and regulated within this historically specific regime of truth. My aim is to denaturalise the language of the policy document in order to unpack its representations of the girl and its naming of categories of gendered difference as a linguistic and discursive artefact. In making transparent the techniques by which the curriculum document attempts to create knowledge of girls in school mathematics, the argument is that the document works as a powerful form of normativity by positioning, locating, defining, enabling, and regulating female learners.

I proceed by first focusing on how the production of gendered difference came to be legitimated through negotiated and contested political ends. This entails a brief consideration of how the textual construction of identity knowledge in "Mathematics in the New Zealand Curriculum" took effect and whose political investments and interests in this construction came to 'count'. I hope to show by this that the theory underpinning the curriculum statement is premised on a set of claims to truth which are historically specific and which are not the only or necessary way to understand school mathematics. Second, I analyse the curriculum document's construction of the subject in terms of its theoretical location in the private/public spheres. This focus is on the key signifiers central to the policy statement's agenda: the individual and pedagogical reality. Third, I reveal some tension confronting the notion of the individual's mathematical reality arising from a competing discourse of difference. Lastly, I briefly examine the concept of mathematical development and the part it plays in the formulation of subject identity and formation.

## Historicising "Mathematics in the New Zealand Curriculum"

On the outer periphery of the discourse of schooling, educators discuss and defend theoretical narratives of the subject (the learner, the teacher) and the institution (the school, the classroom), some of which come to figure in the policy document. When "Mathematics in the New Zealand Curriculum" was introduced to primary and secondary schools in New Zealand in 1993, these notions derived their legitimacy from an era both sensitive to human needs and focused on ways of improving the 'quality of education' in order to arrest public disillusionment with the state. For nearly ten years prior to its introduction, New Zealanders had felt the full effects of government policies, seen most clearly through a rhetoric of autonomy and devolution, but in contexts in which the underlying principles were those of corporate managerialism, increased centralism, and instrumentalist and technicist approaches that accompany the pursuit of efficiency and effectiveness. The effects were made manifest in practices of deregulation, performance contracts, 'user pays' which increasingly permeated and pervaded the New Zealanders' everyday experience.

As part of the Achievement Initiative policy under the umbrella of the New Zealand Curriculum Framework, "Mathematics in the New Zealand Curriculum" is part of the most extensive restructuring and policy reformulation in education over the last century. Radical in essence, New Zealand's educational changes signalled a new order (Codd, 1990). In April 1993 "The New Zealand Curriculum Framework" was launched after extensive community consultation and took the form of a 28-page document for teaching, learning, and assessment in New Zealand schools. It was recognised as a precedent in defining a holistic integrated curriculum and in identifying a generic skills base for an

uncertain future. Its development was influenced by an earlier document "Learning and Achieving", and in part by moves and trends in other Western countries.

Mathematics is one of the seven essential learning areas of "The New Zealand Curriculum Framework." Its translation into government policy via "Mathematics in the New Zealand Curriculum" embodies notions appropriated for the New Zealand context from the National Research Council's 1989 publication in the United States "Everybody Counts - A report to the Nation on the Future of Mathematics" (Neyland, 1994). Historicising it in this way would suggest conflict and oppositional assumptions underwriting its final form. This is certainly the case. Its epistemological development is inseparable from politics. Thus "Mathematics in the New Zealand Curriculum" must be seen as a reflection of the negotiation and compromise that took place during its development. Most of these struggles took place behind closed doors but a glimpse of the dynamics of the conflict is possible within the policy statement. It could be said to represent a dual response to the mathematics community of educators' imperative for improved student understanding and a state imperative for improved demonstrations of numeracy (Walshaw, 1995).

Laying bare the historical constitution of "Mathematics in the New Zealand Curriculum" as a discursive transformation is one step. The issue that needs to be addressed now have to do with institutions and systems and specifically with theories of how the official discourse operates in relation to subjectivity. These are crucial questions for a consideration of the constitution of students as gendered learners. Thus in order to proceed beyond an understanding of how "Mathematics in the New Zealand Curriculum" was made possible historically in relation to existing discourses, practices and conditions, we need to consider what particular form of subject position it produces for the girl in school mathematics. It is possible to unravel a complex knot of related practices and apparatuses which together produce the possibility and effectivity of the gendered learner. In examining this complexity I am claiming that "Mathematics in the New Zealand Curriculum" is fused with a network of political and social discursive practices which produces and polices, among other constructs, gender difference.

## The Text as it Systematically forms the Learner as an Object of Study

School mathematics as a discipline 'validated' through its official text is a power/knowledge formation and therefore is regulatory in its impact. Thus the text can be considered as both a systematic body of knowledge and a regulatory regime of 'knowledgeable' practice through which power is exercised. Through its textual devices

disciplinary truth and regulatory 'disciplinary' power are co-implicated. Those devices in "Mathematics in the New Zealand Curriculum" take the form of words, conventionalised illustrations, linguistic and discursive signs (for example, headings, subheadings, precis, summary points, key concepts, tables, charts, boxes, asterisks and highlights). These are contained within an intertextual and self-referential discourse: the achievement objectives, suggested learning experiences, sample assessment activities and sample development band activities through the six main achievement aims - the 'strands'. These six crucial areas of school mathematics knowledge are categorised as 'number', 'measurement', 'geometry', 'patterns and algebra', 'statistics', and 'mathematical processes'. Together they mark out a field of knowledge that will constitute school mathematics. Both the object-level content and pedagogic forms of the school text are then further circumscribed by textual metanarratives that embody and legitimate theoretical representations of the 'real', namely, mathematics, the learner, development, cognition, pedagogy, skills and the teacher. The very sections are clearly attributable to one discourse type or another. These first order normative knowledges are represented and diffracted in the curriculum document and woven together with justificatory statements.

In order to explore the way in which this discourse produces and constructs its objects of study, it will be useful to systematically itemise the discourses which appear in the text. and draw out the categories relating to the person. Drawing out the terms which put these objects to work will foreground the internal and relatively contingent rules used to make connections. It will also specify the particular logic and ways of thinking which are being prescribed. This will enable us to piece together the subject position of the learner which the text has constructed and any relationships that have been constructed for the learner with others. It will reveal how the document, by producing the terms of school mathematics, and thus the parameters of school mathematical practice, creates what it means to be a subject (Walkerdine, 1984), within these practices.

A consideration of the language of "Mathematics in the New Zealand Curriculum" as it works through the key terms of its objects constituted in and by its regime of truth, enables a view, on the basis of my interpretation of those terms, of the political educational order is made explicit, and the particular *logic* and kinds of *practices* and *orientations* which work to construct a version of the student as a gendered learner. Its textual strategies will clarify the subject positions required of the learner for gaining access to its field.

I begin by looking at those key terms which appear in the whole text of the 'Introduction' on page 7 of the document. The line numbering down the left hand side has been added for easy reference.

1     Mathematics is a coherent, consistent, and growing body of concepts which makes use of specific language and skills to model, analyse, and interpret the world. Mathematics provides a means of communication which is powerful, concise, and unambiguous.

5     As a human endeavour, mathematics involves creativity and imagination in the discovery of patterns of shape and number, the perceiving of relationships, the making of models, the interpretation of data, and the communication of emerging ideas and concepts.

The "New Zealand Curriculum Framework" includes mathematics as one of
10    seven essential areas of learning. Mathematical understanding and skills contribute to people's sense of self-worth and ability to control aspects of their lives. Everyone needs to develop mathematical concepts and skills to help them understand and play a responsible role in our democratic society. Mathematics education aims to provide students with those skills and
15    understandings.

The "New Zealand Curriculum Framework" also asserts the importance of eight essential sets of skills: communication skills; numeracy skills; information skills; problem-solving skills; self-management and competitive skills; social and co-operative skills; physical skills; work and study skills.

20    The need for people to be numerate, that is, to be able to calculate, estimate, and use measuring instruments, has always been identified as a key outcome for education. Mathematics education aims to contribute to the development of the broad range of *numeracy* skills.

In an increasingly technological age, the need for innovation, and *problem*
25    *solving* and decision-making skills has been stressed in many reports on the necessary outcomes for education in New Zealand. Mathematics education provides the opportunity for students to develop these skills, and encourages them to become innovative and flexible problem solvers.

The ability to communicate findings and explanations, and the ability to
30    work satisfactorily in team projects, have also been highlighted as important outcomes for education. Mathematics education provides many opportunities for students to develop *communication* skills and to participate in collaborative problem-solving situations, thereby contributing to the development of many *social and co-operative* skills.

35    Increasingly, information is communicated through the use of data graphics. The communication of information through graphics is particularly common in the mass media. It is important that people can draw sensible conclusions from charts, tables, and graphs of various kinds. At the same time, increasing numbers of occupations demand the ability to collect data, to
40    understand and use information technology for the organisation and interpretation of data, and to present reports and summaries. Mathematics education gives young people the opportunity to develop *information skills* through learning and practising data handling and data interpretation (p7).

The system of knowledge classified as school mathematics possesses its own inner logic.

Discourse markers such as 'coherent', 'consistent', 'specific language' (Line 1), 'skills',

'model', 'analyse', 'interpret' (Line 2), 'concise', 'unambiguous' (Line 4), 'creativity',

'imagination' (Line 5), 'discovery' (Line 6), 'control' (Line 11), 'calculation',

'estimation' (Line 20) 'measurement' (Line 21), 'problem-solving' (Line 24-25), 'decision-making' (Line 25), 'communication' (Line 29), 'collaboration' (Line 33), 'data handling' (Line 41), and 'interpretation' (Line 42), all operate on school mathematics in such a way as to determine what is possible to think, say and experience.

## The Logic of Rationalism

The key terms point first and foremost to the logic of *rationalism* as defining the criteria for thought, speech and action within and about school mathematics, and to its derivative model of *development* which takes the child as central (see Walkerdine, 1993), creative, and discovering. This comes as little surprise because we have already seen in chapter 1 how school mathematics came to be intimately linked with the logic of rational argumentation. "For many...mathematics **is** reasoning. Logico-mathematical structures are the structures of rational thought" (Walkerdine, 1988, p6). Foucault (1970) himself elaborates:

> In France at least, the history of science and thought gives pride of place to mathematics, cosmology, and physics - noble sciences, rigorous sciences, sciences of the necessary, all close to philosophy: one can observe in their history the almost uninterrupted emergence of truth and pure reason. (pix)

The status of rationality in understanding the mind of the learner then becomes a very important issue in the understanding of subjectivising processes in "Mathematics in the New Zealand Curriculum". To understand this, we need to view mathematics as part of the disciplinary society of today's world which grounds both its knowledge claims and the exercise of authority in reason. As Flax (1992) points out, in this scheme, "reason both represents and embodies truth" (p447). This understanding suggests that reason operates identically for every learner. Furthermore it argues for reason as accessing objectively true 'reality'. Those categories for whom the text implicitly defines as engaging with the text as learner are organised and reconstituted in the text through particular ways of speaking. Drawing them out constitutes a way of identifying the particular discourses which construct these terms, and which inform conceptions of what it means to be a learner and what it means to know. Referring back to the 'Introduction' on page 7 quoted above, lines 14, 27 and 32 construct a version of learners in universal terms, as 'students'. Line 42 extends the notion of 'students' wider to embrace 'young people'. Students and young people are disembodied and universalised, constituted as belonging to the wider world of 'everyone' (line 12) and 'people' (lines 20, 37) and in this sense are obligated to become mathematically proficient for democratic citizenry.

The subject in the passage above then prompts and sustains a belief in the existence of a universal, homogeneous and 'essential' human nature, an essence which lies at the heart

of the individual which is unique, fixed and coherent and which makes him what he is. I use the pronoun 'he' purposefully because the child in the educational discourse has implicitly been shown to be a Piagetian androgynous yet a distinctly male child (Luke and Gore, 1992; Walkerdine, 1984). Since the rational autonomous individual learner is male, the girl is centrally and strategically implicated in that discourse, as 'the other'. What emerges is a whole set of assumptions about reality and truth, cause and effect, freedom and the nature of human agency. Thus the learner, as the very rationale for the curriculum statement, is an object premised on the holding of certain capacities. It is not a matter of the mathematics learner merely applying a scientific discourse, but of compliance with sanctioned categorical descriptions.

Earlier, in Chapter 1, I endeavoured to show how the reasoning individual has been central to Western political thought, politics and social organising from the mid-seventeenth century until now. In that exploration, I attempted to demonstrate how the development of reason, as it is grasped today in western society, is the effect of a specific regime of power, and is not necessarily the only way of thinking. Foucault and other poststructuralists claim that what is accepted as rational is derived from power-knowledge formations (Usher & Edwards, 1994) and what is known as the mind or reason is merely an effect of discourse. There is and can never be a transcendental mind. There are no *a priori* categories or concepts that shape what we know in the same ways. For Foucault, the 'foundational' notion of rationality can never provide the means to Truth; it is rather that the norms of rational justification have been constituted by the differential and exclusionary realm of their historical, regulating, political practices.

The unmasking of reason as intimately tied to the social organisation of power becomes crucial to any notion of the place of girls in school mathematics. In Foucault's argument the exclusion and derogation of particular thought structures that represent 'the other of reason', for example, 'irrationality' or 'emotion', are linked to the validation of the Enlightenment project and modern Western thought which derives from it. In other words, the equitable, universally valid and just rationality that forms the basis of Enlightenment thought claims, is able to be sustained by processes of 'normalisation' and 'naturalisation' which involve the exclusion and silencing of those who do not exhibit 'reason'. Clearly it is necessary here to look at those who represent reason and those who do not and note the social and historical conditions in which certain discourses and practices of reason's governance emerged through the discourse of mathematics. It is not possible to engage in that entire history. But some arguments about the reasoning learner made by feminists need to be reiterated.

## The Feminist Response to Rationality

The feminist critique of the ways in which the concept of rationality is used is well documented (for example, Hekman, 1990; Irigaray, 1985; Kristeva, 1986). This analytical body of work is centred on a complex and gendered history of reason and human nature and whilst it could not be said that these attacks offer any uniformity, they do share many of the themes that are developed by Foucault. But, as Hekman points out the feminist critique is more radical in that it defines causes whereas Foucault deals only with symptoms. It begins by arguing that Enlightenment values are problematic to the extent that they naturalise rationality, implicitly relying on and legitimising a privileged male perspective. As Benhabib argues, the universalism upon which much Enlightenment thought is based is defined 'surreptitiously' by identifying the experiences of a specific group of subjects as the paradigmatic case of the human as such. "These subjects are invariably white, male adults who are propertied or at least professional" (Benhabib, 1987, p81). The same point is taken further by Ellsworth (1992) who claims that "the myths of the ideal rational person...have been oppressive to those who are not European, White, male, middle-class, Christian, ablebodied, thin, and heterosexual" (p96).

The feminist critique generally looks at what is taken as the authoritative base of rationality and challenges this characteristic orientation of thinking which argues that such modes of thinking are common to different individuals and give access to a true reality. Weedon (1987) notes that for the French feminists critique revolves around abandoning the traditional rationality and celebrating irrational forms of discourse and subjectivity, beyond the realms of the rational cogito, marginalised or suppressed by the rationality of patriarchy. While their solution of reversing the rational-irrational opposition is not seen by poststructuralists as being entirely productive, nevertheless they meet on another level with the poststructuralists by insisting that girls' reasoning capacities are not 'naturally' deficient. They argue that rationality as one of the primary organising principles of democratic citizenship of western society, maintains relations of social inequality. Insofar as it relates to "Mathematics in the New Zealand Curriculum", the notion of rationality as universal, *a priori* and absolutist, is a regulative ideal which denies the female, prompting and maintaining the subordination of girls.

Emergent with this idea is the notion of the girl, both as an object of mathematics education and as one engaged in school mathematics, who presents an issue and a *problem* for understanding her subjectivity in the mathematics classroom. Beyond the

realm of education the notion of the deficient girl circulates in various forms but more obviously as slogans, for example, 'girls can do anything[1] '. It is founded on a set of assumptions about knowledge and the female subject, assumptions which equate reason with progress, and knowledge with emancipation from deficiencies, according to the male norm. These power regimes are formed and sustained through certain erasures, constitutive exclusions, for example, the erasure of the feminine, and this is nowhere more evident than in the regimes of truth constructed in the early gender research through their attempts to explain the subordination and exclusion of girls in mathematics.

The significance of this draws attention to the double-bind of which Irigaray (1985) speaks. Masculinity figures as the standard according to which both 'sameness' and 'difference are assessed in the social field: hence women are either deemed to qualify as identical to men or as qualitatively different from men, but in either case are posited as the 'other' of the 'same'. Girls in mathematics become boys' *specular other*. (Irigaray, 1985). It is these notions, together with the support and authentication they received from institutions and social and educational practices, that fashion the 'reality' of the schoolgirl in mathematics and offers her appropriate ways of being and behaving within the classroom.

## Pedagogical Relations

Interrogating the specific deployments of the discourse of rationalism in school mathematics is to pose the question of what qualifies as learning reality in school mathematics. Theoretical decisions about learning have important implications for the ways in which pedagogical relations can be conceptualised and enacted. Investigating those aspects, both implicit and explicit within the text "Mathematics in the New Zealand Curriculum" enables us to draw out the quasi-structuralist rules in operation which define the discursive space for the pedagogical relation in school mathematics. In the following passage "Mathematics in the New Zealand Curriculum" sets out certain fundamental ideas about the activity of learning.

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[1]        In 1995 Willis was to suggest that this body of work which presumes the 'woman problem' in mathematics, disregarding contrary information, extends it throughout the social field. In its wider distribution across communities the 'woman problem' situates itself as a more extensive social problem. Hence its effects are to be found throughout contemporary discourses in New Zealand, for example, in the production and marketing of women's abilities (for example, "Girls Can Do Anything", a media and school promotion of the New Zealand Department of Labour, 1983) and in the juridical construction of women in relation to the state (for example, EEO policies in schools), all of which carry specific political agendas.

1   This scheme explicitly recognises that each learner is an individual
whose learning development and rate of progress is different from others.
Different students will be ready for particular mathematical content and
experiences at different times (p17)

5   As new experiences cause students to refine their existing knowledge and
ideas, so they construct new knowledge. The extent to which teachers are
able to facilitate this process significantly affects how well students learn. It
is important that students are given explicit opportunities to relate their new
learning to knowledge and skills
10  which they have developed in the past (p12)

A balanced mathematical programme includes concept learning, developing
and maintaining skills, and learning to tackle applications. These should be
taught in such a way that students develop the ability to think
mathematically.

15  Students learn mathematical thinking most effectively through applying
concepts and skills in interesting and realistic contexts which are personally
meaningful to them. Thus, mathematics is best taught by helping students to
solve problems drawn for their own experience (p11)

Teachers can create opportunities for students to develop these
20  characteristics by encouraging them to practise and learn such simple
strategies as guessing and checking, drawing a diagram, making lists,
looking for patterns, classifying, substituting, re-arranging, putting
observations into words, making predictions, and developing proofs (p11)

The importance of the use of apparatus to help students form
25  mathematical concepts is well established. Using apparatus provides a
foundation of practical experience on which students can build abstract
ideas. It encourages them to be inventive, helps to develop their confidence,
and encourages independence (p13)

Like other official texts in mathematics education "Mathematics in the New Zealand
Curriculum" is a metatextual commentary (Luke et al., 1989) about the value of a
particular theory of learning. As such it presents a theoretical justification for a pedagogy
that aims to reform mathematics teaching, thereby creating new modes of activity, new
ways of being and new interpersonal relationships. Its particular regimes of truth make
possible both what can be said and what can be done. That commentary needs
concretisation. Here I want to investigate how this passage shapes difference by
encouraging and sanctioning particular pedagogical relations and practice. Looking
systematically at the practices it engenders and legitimises, my focus is on
interdiscursivity within a framework constituted through new pedagogical relations.
Foucault claims that "there can be no statement that in one way or another does not
reactualize others" (1972, p98). Here I consider how the official text actualises some
practices about the pedagogical relation at the exclusion of others.

It would be helpful here to analyse certain aspects of sentence structure in this passages.
This will reveal the argumentation that is being presented and the particular educational

voice and ethos from which it speaks. In turn this will provide insight into the types of practice sanctioned and the forms of social identity constructed for learners in the text. Beginning with looking at verbs, as they relate to the teacher, in the second passage taken from the section headed 'Catering for Individual Needs', the text explicitly expresses its requirements of the teacher in the pedagogical relation with reference to two actions: 'facilitate' (Line 7), 'are given explicit opportunities' (Line 8). The third passage drawn from 'Approaches to Teaching and Learning in Mathematics' asks that teachers teach by 'helping' (Line 17) students. In the same section teachers are required to 'create opportunities' (Line 19), and that teaching is in part to do with 'encouraging' (Line 20) students.

Using these verbs to map the different versions of the educational world which coexist in the passages, enables us to identify the discrete ways of speaking and 'doing' that are at work in this text. In relation to the learner the role of the teacher is to facilitate, help, encourage, and create a mathematical learning situation. These activities hint at the responsibilities of the teacher and at the power he/she wields, positioned as facilitator, identifying and focusing on problems and issues. It can also tell us about the assumptions of the learning process which are at work. Below I have listed the nouns as found in the passages above (and, in brackets, the contextual sense which I make of them) as leading to a more robust way of exploring the differential rights and responsibilities of the teacher and the learner and the network of pedagogical relationships in which the teacher and the learner have both been constituted.

'individual' (unique, to be singled out)

'development' (idiosyncratic to the learner)

'progress' (made at different rates)

'content' (body of mathematical knowledge)

'experiences' (mathematical teaching and learning opportunities that present)

'times' (marker of temporal stages for learning)

'knowledge' (personalised understandings of mathematics)

'ideas' (personalised conceptualisations of mathematics)

'opportunities' (classroom practice as deemed relevant to each student)

'skills' (conventionalised techniques)

'programme' (identifiable boundaried content and methods for teaching and learning)

'concept learning' (as in abstract notions)

'applications' (as in contextualised activity)

'ability' (marker of mathematical development)

'thinking' (the correct way to 'do' mathematics)

'concepts' (abstractions)

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'contexts' (the real world situations)

'problems' (the best way to approach mathematics)

'characteristics' (that which is required of the modal student)

'strategies' (ways of going about mathematics)

'diagram' (representation of a mathematical situation)

'lists' (itemised recordings)

'patterns' (similarities according to some given criteria)

'observations' (what is seen as relevant to the problem)

'words' (linguistic communication, as opposed to symbols)

'predictions' (what might happen in the future as deduced from a problem solution)

'proofs' (processes, conventional or otherwise, to establish meaning)

'apparatus' (equipment, either everyday or specially devised for modelling a situation)

'foundation' (base of resources)

'confidence' (seen as crucial, and supposedly not often usually apparent)

'independence' (able to work by oneself)

Key words are repeated ('experiences', 'knowledge', 'skills', 'concepts', 'opportunities', 'apparatus') and these, taken together with the remaining words construct a version of the teaching/learning process, normalising the 'space' and 'scope' in which pedagogy is to take place. The passage controls this space by fixing limits around what can take place. In relation to both the well-being of the individual and society at large, the teacher must carry out these obligations and "relate...new learning to knowledge and skills...developed in the past" (Lines 8-10). Looking at how these operative words cohere within the text clarifies these social and educational experiences as enabling individual progressive growth and collective social transformation. They form the learning reality for the student, which in time, will become taken for granted pedagogical practice. Foregrounding reasons, norms and ethics like this for pedagogical practice is a form of regulatory power.

Lines 5 to 6 reveal that it is the learner who constructs a world ('As new experiences cause students to refine their existing knowledge and ideas, so they construct new knowledge'). Cognition is thus understood to be a process of 'meaning making' in which the individual makes sense of prior, socially-developed knowledge ('individual', 'ideas', 'skills', 'concept learning', 'contexts', 'thinking'). Drawing on Davis's (1995) argument, it is a matter of constructing personally and socially viable 'theories' of the ways in which the world works ('patterns', 'observations'). Mathematics is a socially produced phenomenon ('opportunities') and mathematical activity is a form of rhetoric ('words'). In this passage, Truth is enacted not by scientific mandate but by linguistic

performance so that mathematical knowledge is demystified and reconstituted into the creative world of history and action.

What is important here is that the text provides evidence of particular powerful disciplining practices shaping the conduct of the pedagogical relation. Taking seriously the plight of the individual student whose work is undermined through a hierarchical knowledge system militating against them in the classroom, it assembles a mediated relationship between the teacher and the student, a relationship whose ideational field of practice revolves around a deep truth which is both known and hidden. This marks out a logic for finding that truth: the compliant teacher will, through idiosyncratic 'readings' and interpretations within classroom practice, forge this mathematical 'truth' about the 'mind', and ultimately about culture and society. Without addressing constructivism directly, the text appropriates its situated learning ideas in ways that negotiate them for New Zealand classroom practice (see Barton, Begg, Butel and Ellis, 1995, for a discussion).

As a movement which has wielded a major influence, constructivism is essentially a theory about the limits of human knowledge[2] - a belief that all knowledge is necessarily a product of our own cognitive acts. It is Piaget (1937) who is deemed the "great pioneer" (von Glasersfeld, 1990) and contributor of constructivist thought. When we look at epistemology in Foucault's terms, it is one of the modern apparatuses of social regulation: it not only defines what will be taught and thereby determines what counts as knowledge, but also defines and regulates the learner as well as teaching and learning. It creates technologies and practices through which learners can be managed. These techniques of management form the power/knowledge couplet. To understand this requires that we look upon these regulatory practices as producing self-disciplining through their reliance on technologies of the self, which are actualised and resisted through the body.

> But in thinking of the mechanisms of power, I am thinking rather of its capillary form of existence, the point where power reaches into the very grain of individuals, touches their bodies and inserts itself into their action and attitudes, their discourses, learning processes and everyday lives. (Foucault, 1980, p39)

How "Mathematics in the New Zealand Curriculum" as a regime of truth produces self-disciplining is ultimately a question of the theoretical position it takes on the pedagogical subject. This position, as Luke and Gore (1992) have suggested, has significant political

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2       Constructivism, is a collective name for an epistemological movement. As such it is not readily classifiable for it refers to, as von Glasersfeld has noted, a number of quite different positions. My use of the term 'constructivism' is not towards specific perspectives. Rather, I use the term in the way that it is taken more generally in mathematics education to refer to a theory of learning.

and ethical consequences for how teachers treat students, since the pedagogical relation is about linking theoretical positions to practical applications. In revealing its theory of learning the text authorises a knowledge/power relationship not only between the teacher and student but also between the student and mathematics. It constructs certain learning positions for students, specifying these within a possible world of school mathematics. These contain and put boundaries around the learner's reality and thinking in mathematics and they have to be named.

The constructivist learner, as Lerman (1996) has argued, constructs her own subjectivity and knowing from sensorimotor, social and textual experiences (p147). The learner is an 'individual' who, as an entity, can be described definitively, once and for all. We have already seen that the learner in "Mathematics in the New Zealand Curriculum" is rational and male. To the constructivist the learner is a pre-existing embodied, classed, gendered and racial individual whose existence is an empirical natural fact, or, to the constructivist with a more social inclination, as a cultural fact. What emerge from this are learners freely and rationally constructs their own meanings, dissociated from regimes of social power. What is important is that the production of learner positions which emerges instantiates particular forms of institutional knowledge. These relate to *humanist* notions of subjectivity, power and change. I have made this claim on the basis of my interpretation of the scholarly work on constructivism of Cobb (1994), Cobb and Yackel (1996), Ellerton and Clements (1992), Klein (1997, 1998, 1999), Lerman (1996), Phillips (1995), Taylor (1996), Watson (1998), and Zevenbergen (1996).

In the textual rendering of pedagogical relations above, drawn from passages in "Mathematics in the New Zealand Curriculum", the teacher's task is to search for a 'deeper' interpretation of mathematics drawn from the individual's experiences[3] . Much of the structure about the individual's knowledge may be hidden or may compete with that of the teacher, but given the proper facilitating hermeneutic conditions, the true description of mathematics will, it is implicitly claimed, ultimately emerge. In the recovery and naming of the internal conditions of thought the learner is ostensibly powerfully positioned as the source of meaning and value in mathematics. In the pedagogical relation the teacher is 'on the same side' as, or deferring to, the student. And as teachers and students engage in a mathematical discussion about the world, they will uncover together the same mathematical reality. From the vantage point of discourse

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[3]      A method and practice which studies the self-interpretations or their objective properties, of the researched, as if these gave the researcher privileged access to meaning, to universal knowledge, is highly suspect. Poststructuralism would question the idea of a cohesive 'depth' to meaning which is said to be accessed through adequate interpretation and that can serve as a standard against which interpretations can be evaluated.

analysis on the above passages of "Mathematics in the New Zealand Curriculum", however, the imperative toward individual hermeneutic enablement registers its inscription within a regime of truth, constrained by the implicit and explicit powers and limitations of teachers. In this sense the text that claims to be a strategic liberatory effort, is nonetheless linked to technical expedience and power.

If it is easy to re-present pedagogical work as revisioning the value of the subjective, it is not so easy to suggest what is to be gained by ignoring the politics of knowledge production. Most constructivist educators would accept their person-world findings as genuinely defining a framework of truth possibility, and would insist that truths uncovered in the classroom lie outside the sphere of power. But by side-stepping the question of the politics of practice they defer to meaning and authority and thus underplay the role that critique and evaluation play in knowledge production, undeniably ignoring their own critical part in the deployment of power. One way out of this impasse has been suggested by Scott (1994). Speaking in the feminist literature, her solution is two-fold: she suggests the unmasking of power relations through a critical interrogation of the exclusionary operations by which 'positions' are established, and secondly, a denial of the consequent dichotomous formation of political choices.

## Valorising Difference

At another level, "Mathematics in the New Zealand Curriculum" sets out to resolve a conflict - one centred on the definition of the subject. The text first sets out the theorisation of the subject of earlier curriculum statements, and at the same time attempts to reconcile this with the emergence of new configurations acquired from new theories of the social and educational precedent from other countries. This has produced a shift in the technologies of education, aligned to the social and political nuances of the times. Thus the document highlights what it means to be a subject in constructivist terms and tries to locate this within social and cultural terms. It formulates an agenda for change with relevance to individuals who have been subjugated in discourses, marking their differences as negative. In this respect the text is oriented retrospectively to those theories of learning from previous curriculum statements and prospectively to the anticipated action and speech of future curriculum developers and to teachers and educators. This is Kristeva's (1986) notion of 'vertical' intertextual relations (p36) between a text and other texts which constitute its more or less immediate or distant texts.

The text developers are functioning in two situations and two sets of subject positions simultaneously. In doing this, they produce readers in contradictory ways. The central contradiction lies in the discursive positioning of the gendered learner, constituted with

an identity and with a set of textual and social relations. It is my contention that what is presented, is an ambiguous and bi-vocal narrative. In the instance of discourse-at-work through the 'Introduction' in "Mathematics in the New Zealand Curriculum" the learner's position as essential and male, sits uncomfortably alongside a dissenting discourse read through the section titled 'Catering for Individual Needs'. Against the normative discourse of the essentialised learner, a competing discourse of knowledge about the learner as a construction of 'difference' circulates around notions of ability, background, gender and ethnicity. This educational discourse of difference constitutes the 'different' learner as a pathological, cultural and gendered subject through the constructs 'lower ability', 'exceptional ability', 'Maori students' and the category 'girls'. It is through this construction that the learner's identity is mapped onto, to use the words of Luke and Luke (1995) "a complex grid of formal and informal school and out-of-school discourse and attendant social practices" (p374).

Turning to the question of the way in which a normative position is produced for the female learner requires a consideration of relations of the discourse through which and in relation to which the identity 'girl' is made possible.

1       The suggested learning experiences in this document include strategies that
        utilise the strengths and interests that girls bring to mathematics. Techniques
        that help to involve girls actively in the subject include setting mathematics
        in relevant social contexts, assigning co-operative learning tasks, and
5       providing opportunities for extended investigations (p12)

And later:

        Girls early success in routine mathematical operations needs to be
        accompanied by experiences which will help them develop confidence in the
        skills that are essential in other areas of mathematics. Girls need to be
        encouraged to participate in mathematical activities involving, for example,
10      estimation, construction, and problems where there are any number of
        methods and where there is no obvious 'right answer' (p 12)

Through these texts the female learner enters into a politics of discourse which becomes a site for differential engagements and positionings in discourse (Foucault, 1977), in relation to male students. The female learner enters from a different location, has a different motivation and a different reading of and access to power. She learns of the classificatory grids which have been formulated. These are what Hasan (1986) refers to as differential *semantic resources* and they are laid bare in these particular texts, determining what counts as mathematics in secondary school (*not* routine mathematical operations; *not* single-method and single-solutioned problems), and about how school mathematics is gendered (boys have confidence in multifaceted approaches and solutions, girls do not).

The curriculum statement organises difference by casting girls in school mathematics as pathological. Because these girls lack autonomy over their own schooling they are in need of liberation from oppression ('needs to be accompanied', lines 6-7; 'will help them', line 6; 'need to be encouraged', lines 8-9), the focus is on securing freedom from stereotypical gender identity and from overt regulation and manipulation. What this suggests is that the official text on school mathematics for New Zealand classrooms implicitly assumes deficiencies within girls and presents prescriptive remedies and packaged answers to alleviate these deficiencies. The text by fixing its subjects within its classificatory grid, disciplines them and exercises power over them, by labelling 'girls' as lacking in confidence, and naturally drawn to 'cooperative learning tasks'. Power/knowledge is integral to the text and it is through these formations that the 'girl' is produced and is subjected to systems of regulation aimed at governance.

The shift to a liberatory curriculum emerged from a challenge to Western metanarratives from feminists and others to give voice to oppositional cultural forms and events. Working to escape from a logic of binaries, these theorists have argued for the concept of *difference*. Indeed there is a growing presence of this theme, along with the pluralistic desire to make a space for diversity, in mathematics educational scholarly writing and research (Ernest, 1994). Although their educational aims and values are articulated in unique ways, those who promote the valorisation of difference have a common interest in emancipation through the transformation of a unjust social system into one that is more democratic. However, as I have argued elsewhere (Walshaw, 1999) the methods of emancipatory-minded academic educators concerned by an unequal distribution of power is more than merely academic: they are also said to be empowering in that they aim to give voice, and situatedness priority, to learners who are disenfranchised and disempowered through the social markers such as race, class, gender and hierarchy in the classroom.

In the extensive gender projects in mathematics education of the past two decades born out of such theorising the discourse markers are to do with emancipation, freedom from oppressive identities, transcendence, and social transformation. Indeed, the mobilising principle behind most versions of feminist emancipatory work for girls in mathematics education is a commitment to freedom and equality. Thus the priority of this liberatory discourse is to achieve actual equality of females with males within the hierarchies of mathematics education, by providing the means by which girls might be freed from oppressive identities, forms and events, by becoming rationally empowered, to transform themselves and the social world in which they live. From this it is easy to see how the deficient female learner became an ideal subject of progressivism and emancipatory visions, as articulated in the curriculum statement.

Interventions become a means by which this commitment can be substantiated and realised. This commitment is clearly expressed in the rewriting of the curriculum document as girl-inclusive. "Mathematics in the New Zealand Curriculum" interventionist version of liberalism is premised upon a set of claims to truth which are historically specific regarding the 'nature' of women and girls in society and the status of mathematics in society. Underwritten by a desire for new norms of social and educational relations, the curriculum relies on an assumption that rationality is shared equally by all individuals, irrespective of historical or cultural circumstances, just as it takes 'oppression' to be self-evident and its cause specifiable. Moreover, it takes for granted the impartiality of a 'true' education and culture for girls, and the power of educators to effect change in schools, and thus society, and hence in their ability to effect 'equity'.

This vision of equality and self-determination has considerable persuasive purchase, promising the antithesis of all that is undesirable for girls in current educational relations in school mathematics. It is also compelling in that it offers the potential for envisaging and building a new form of politics. Motivated towards this vision the curriculum document reveals a resolution to direct, shape, and control educational experiences in order that females might attain and achieve at the same levels as males. Such ideals are characteristically seen as emancipatory, given the identification of girls by feminists as a disadvantaged group (Densem & Leahy, 1992). Earlier in 1989 the New Zealand Department of Education had argued that we must "help educators achieve equitable learning opportunities for all learners...to improve the learning experience available to girls and women" (p9). The current New Zealand mathematics curriculum document takes up this point. It presents a theoretical justification for a curriculum aimed at critiquing and transforming existing educational organisation.

In 1994, Walkerdine, in her article "Reasoning in a Post-modern Age", argued that explanations continue to position girls in mathematics with a "lack" (p66). This deficit logic and the compensatory measures it engenders are in a sense particular regimes of truth in that they work within the binary system to *regulate* gender identity, whilst simultaneously claiming emancipation, transcendence and freedom from oppression. For our purposes this suggests that the practices that the official document proposes which articulate a commitment to developing non-sexist strategies for producing self-managing students beyond the constraints of traditional gender categories, in fact institute social processes of regulation and control. Through the curriculum statement, categories of difference and gendered self-other identifications are named and established. Viewed from the vantage point of critical discourse analysis, the policy document provides evidence of particular disciplining practices that shape notions of difference through its selection of semantic resources and its depiction of categorical distinction of its world.

This is a significant shortcoming of the official curriculum text in that it anticipates and encourages the proliferation of the notion of girls' general mathematical inability. It *presumes* 'the woman problem', despite evidence from numerous researchers (see Blithe, Clark, & Forbes, 1993; Feingold, 1988; Hyde and Linn, 1988; Hyde *et al.*, 1990; Keef, 1990; Kimball, 1989; McDonald, 1992; New Zealand Ministry of Women's Affairs, 1992, 1998; Orr, 1985; Stockard and Wood, 1984) that girls' achievements now appear to surpass those of boys. The text does not address the possibility of girls' simultaneously contradictory positions within school mathematics. The subjectivity of the girl is assumed to be transparent and universal, when in Foucault's terms, she is not an abstraction, but has a defined history and relationship to the world.

## A Pedagogical Strategy for Girls

> In many cases in the past, students have failed to reach their potential because they have not seen the applicability of mathematics to their lives and because they were not encouraged to connect new mathematical concepts and skills to experiences, knowledge, and skills which they already had. This has been particularly true for many girls, and for many Maori students, for whom the contexts in which mathematics was presented were irrelevant and inappropriate. These students have developed deeply entrenched negative attitudes towards mathematics as a result.
>
> An awareness of these issues has led to improved access for girls to mathematics, but the participation rate of female students in mathematics continues to be lower than that of male students at senior school level and beyond. This limits later opportunities for girls and women. (p12)

The text argues for a pedagogical strategy, delineating a method for the teaching of girls (and Maori students) in school mathematics: one begins with a problem of distinctly female 'interests' or 'strengths' and draws upon mathematics as a means for dealing with the problem of girls' lack of success because their interests have been subordinated, separated or devalued. The curriculum document establishes a benchmark for what will count as 'doing mathematics' for girls that will require that the teacher reads reflexively from the girls' world to mathematics, grounding mathematical understanding in its uniquely feminine application. Girls' ways of being in the world are connected in classroom practice with mathematical knowledge. The power/knowledge relationship authorised here is not just between the girl and the institution of mathematics education; it is also between the parties within the pedagogical relation; the teacher and the female learner.

These efforts parallel revisionist feminist attempts, noted in Chapter 2, to 'find a voice' for girls in school mathematics. Here a mathematical reconstruction is understood as providing both a place and power to speak. This engagement works very well for debating the logic of more traditional theories of knowing and has wider implications beyond school mathematics for the learner. This is because a speaking position for the learner could be seen as the individual's struggle to create and fashion meaning, assert standpoints, negotiate with others, establish convictions necessary for exercising civic courage, and solve problems in the social arena.

However the issue of speaking on behalf of girls is not a simple matter of presence or absence, a suppression versus an enabling.[4] The writing of normative mathematics from a fundamentally different standpoint as if it were a corrective to earlier oversights resulting from an inaccurate or incomplete vision, is dependent on a referential notion of girls' experience which takes the evidence of experience as a reflection of the real. In poststructuralism this appeal to experience as uncontested evidence is highly problematic. It is precisely this self-evidence of identities which works to naturalise girls' difference from boys in school mathematics and reify agency as an inherent attribute. This weakens the official document's analytic power of knowledge production and forecloses the possibility of examining those assumptions and practices that excluded difference in the first place.

Brodkey (1987) notes that the narrative of lived experience can never be synonymous with experience itself. Questions about the constructed nature of girls' experience, about how subjects were originally constituted as different, and about how the girl sees herself in school mathematics, are all lost. Highlighting the experience of a different group precludes the recognition of contradictory realities in school life. It does not expose the inner logics at work in repressive mechanisms. The contradiction here is that while girls' learning experience is theorised in universal terms, it is in actuality socially negotiated. Each girl's knowledge is constantly negotiated through her interactions with others and accordingly masquerades as either affirmation or challenge, depending on who those others are. That investigation needs to be approached through attending to the discursive processes that position girls and produce their experiences. Girls' experience then cannot be seen as the authoritative evidence which grounds knowledge claims. It is rather that which we seek to explain. The disciplining power of significant others within the

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[4]       Writing in the educational literature, Miller (1990) has warned of the subtle and usually unconscious ways in which attempts to help others may become infused with unexamined assumptions about the 'right' ways to act. As Miller argues: "These 'right' ways often reflect the attitudes and stances of those who are in charge and who thus have power to decide, rather than represent the actual needs or desires of those identified as needing 'help'" (p53).

classroom to sustain, to constrain, and to legitimate certain ways of speaking and forms of knowledge becomes central to an understanding of the knowledges of the mind of girls, and their subjectivity.

## The Issue of Development

For the constructive learner, a normalising grid for performance marks out the regulated activities that will constitute 'calculus' for 'level 7': six achievement objectives are identified and labelled. These require the student to enact a particular behaviour (eg, 'sketch', 'explain', 'determine', 'use', 'apply') in order to comply with the model of the rational citizen. Modal auxiliaries are offered as 'suggested learning experiences', 'sample assessment activities' and a 'sample development band', acknowledging the contingency of local teacher decision making and particular student representation. These prescribed actions do not rely on the completion of prior calculus work primarily because this is the initial presentation of work in this domain within "Mathematics in the New Zealand Curriculum". At the same time, however, there is an implicit belief that effective learning of calculus concepts is conditional on and "depends on a prior understanding of other ideas" (p16).

Measurement and Calculus Level 7 (p82-3)

*Achievement Objectives:*

Developing concepts of rate and change

Within a range of meaningful contexts, students should be able to:
* sketch the graph of a gradient function from the graph of a function and explain the relationship between them;
* determine and use and expression for the rate of change of a variable and apply it to practical situations such as maximum, minimum, velocity, and acceleration;
* use integration and anti-differentiation in real and simulated situations.

*Suggested Learning Experiences*

Developing concepts of rate and change
* exploring the historical development of calculus and its notations;
* investigating the relationship between a variable and its rate of change through experimental and practical work;
* investigating and interpreting the relationship between a graph and its slope from a rate of change point of view, for example, by using a graphics calculator or suitable graphing package to "zoom in" on a point on a graph until the curve appears to be a straight line, and then find the gradient;
* discussing applications of differentiation, including practical problems on maxima and minima;
* calculating areas under curves by a variety of means such as counting squares, drawing trapezia or rectangles, or by methods of their own choice;
* discovering a relationship between anti-differentiation and integration;
* applying integration, including its use in finding areas under polynomial curves.

This set of achievement objectives is listed as the requisite competence for learners at level 7, one of eight loosely-defined stages, outlined within a system that sets up a loose correspondence between years of schooling and mathematical content and experiences. This list documents discrete subskills, which, reassembled cumulatively, are taken as knowledge embodying educational value, and by implication, beneficial both to the individual and to society. A chart on page 17 clarifies that the mathematical content above is designated for New Zealand learners who will for the most part be year 12, of an age cohort of 16-17 years.

The official authorised conventional code for knowledge production situates learning positions by its focus on particular knowledge competency domains. This textual regulation of the learner is achieved through powerful positioning devices that are tied up with the longstanding desire to regulate populations towards self and social empowerment. This was not to be achieved through the use of sovereign power but through a modern form of power of strategic practices working through the medium of minds and behaviour. According to Foucault, modern power emerged with the advent of modern institutions. Educators of course did not initiate an interest in development as a technology for government. That interest has its origins in psychology, in evolutionary biology, and historicising it further, in the Enlightenment narratives. But, Walkerdine (1984) argues, it was education which became heavily dependent on psychology's scientifically validated pedagogy.

Can age levels reflect objective experience? Precisely because this question was undecidable, psychology sought to pin down a solution in the form of a scientifically validated enterprise. Developmental psychology took individuals as the object of its gaze and directed itself towards the production of concepts, meanings, codes and the organisation of scientific management of these individuals. It made use of a model of nature derived from evolutionary biology, and incorporated aspects of Piaget's work to construct and legitimise a disciplinary regime of truth about natural stagewise progression of knowing. But this resolution to the problem of harnessing age to knowing was not acknowledged as spurious: instead the scientisation of the individual was said to be based upon nature and truth. What is important for us here is how the developmental model naturalised the girl, legitimating what was able to count as 'female nature', the specificity of which has already be noted in Chapter 1.

When psychology takes development as an external source of information which will explain what is going on, we find that what is at stake is an epistemological theory that offers a method for analysing the competency by which meanings are made. Education,

defined around psychological parameters, by explicitly theorising that categories of stages accurately describe how things happen, implicitly endorses the premise that there can be an authoritative definition for development. Development in the educational framework means natural progression and what passes as school knowledge assumes an unmediated correspondence to the domain of the real. This notion is powerful and compelling, and is argued by a circular logic of a presumed sequence of development, justifying not only competency-based assessments, but also the educational policies and official regulations themselves.

Critical of these existing hierarchical notions of better and closer stages to ultimate knowing and its appeal to and incorporation of existing normative definitions of girls, Walkerdine (1984, 1988, 1989, 1992, 1993) has written extensively on psychology and education's production of 'the child'. She argues that this 'development', both historically and contextually variable, should more appropriately be read as the *effect* of policies and regulations, rather than a *justification* and *validation* for them. Power-knowledge formations are integral to its practices and it is through these that the learner becomes a 'subject' and 'subjected'. Viewed in this way, the mathematical development of the learner is not 'natural' but merely a *production* which has to be understood in relation to its historical formation and effectivity. The competencies stated in the discourse - 'sketch', 'explain', 'determine', 'use', 'apply' - all derive their meaning from the position and function within the discourse itself. The discursive practice itself specifies the terms and limits of mathematical practice for the learner, and in this sense these competencies cannot be taken as prior to discursive practice.

Development is pedagogical, in that it produces a set of observational and empirically verifiable facts of progress in school mathematics as classified according to the given sequence and with certain effects. What this means for the female learner is that those activities, behaviours and actions which comply, are read as normal development, and hence are sanctioned. Those outside the practices are pathologised. Whatever cognitive development she undergoes has meaning only insofar as it is coded with reference to those practices. Her 'natural' ability is calibrated in minute detail, read through this discourse in which she becomes overtly classified and covertly regulated, normalised, and monitored as a fast, normal or slow learner. From what are apparently impartial criteria and norms of a psychometric scale of classification she learns the truth of her 'natural' mathematical ability. The fact that the truth of her ability happens to be an apparatus of observation and surveillance is obscured from her. To this extent she becomes an embodiment of the real and true learner in school mathematics within a psychological domain of natural development and skill.

Poststructuralists claim that 'cognition' is founded on a problematic model - the model of knowledge as representation. For them, cognition is not hermeneutically interpreted in terms of the meanings it reveals but is understood as the effect of a specific regime of truth. Analysing the learner by these means is to argue that the notion of a subject who exists prior to language, and is the origin of all meaning, is a *fiction*, generated by the structural rules that govern discursive formation regulating all thought and speech. It makes little sense then to speak of the constructivist attempt to search for a 'deeper' interpretation of the individual as if such an endeavour could strip away layers and draw out true knowledge and understanding. That process is fraught with difficulties. If social practices are central to the very formation of the learner's subjectivity, thinking of mathematical knowledge as an exercise of unpacking truth is a conceptual impossibility since there is no transcendental learner.

By writing the pedagogical act as a set of rhetorical and generic strategies for girls the curriculum document is able to produce a position from which the learner of school mathematics can be written for a pedagogical history. But this whole venture is problematic right from the start. In placing the individual and her interpretive and negotiating capacities at the centre of analysis, the curriculum statement's interests are in constructing law-governed regularities: knowledge is viewed as neutral and is canonised as 'fact', behaviour is equated with outcomes that can be predicted and controlled, and the subject is romanticised as an autonomous individual free from the forces of social structures.

## Conclusion

In this chapter I have undertaken a feminist deconstruction of some of the key terms of "Mathematics in the New Zealand Curriculum". This is not of the form of conventional analyses in mathematics education but more in the range of a practice problematising the assumptions of the current school mathematics project. Its methodological strategy looks through description and precedent to expose those concepts operating as instruments and effects in the marginalisation, erasure or exclusion of girls from the mathematical community. The intention was not to censor the usage of these terms but to subject them to critical reinscription and redeployment. Rethinking the terms in this way generated a different analysis in the consideration of who qualifies as a subject in mathematics in New Zealand schools.

"Mathematics in the New Zealand Curriculum" as the official policy text for mathematics teaching and learning in New Zealand schools transmits and reproduces large-scale knowledge. What this analysis has revealed that inscribed within it is "a relation of

surveillance,...not as an additional or adjacent part, but as a mechanism that is inherent to it and which increases its efficiency" (Foucault, 1977, p176). It is part of the modern technologies for the systematic governance of people and hence has political knowledge effects. These effects range from pedagogical apparatuses of observation and regulation, to the mapping of learners onto a psychometric scale of classification, to the gatekeeping of meritorial rewards or impediments for gendered learners. I have identified the discourses of rationalism, of a revised pedagogical interaction, of difference working for girls' inclusion, and of a psychological natural development, each of which produces particular forms of organisation and of sociality. Within each of these discourses the gendered learner is centrally and strategically implicated.

What the learner comes to know as taken-for-granted identity within a possible world of school mathematics is a textual construction. In Foucault's terms identity is an exercise in education-based institutionalised governmentality because all knowledge is embedded in relations of power. What Foucault's analyses of modern forms of government have made clear is that much of what passes for crucial areas of knowledge in our culture is inseparable from relations of power which that knowledge reinforces. The practices and positions which mathematics produces serve to instantiate its authority and power. By this I mean that mathematics exercises power through its regime of 'knowledgeable' practice. Simultaneously it regulates the learner by a process of observation and surveillance, as recorded in the set of criteria and methods constituting what it takes as its knowledge. Thus mathematics education is part of the production of truth about learners. Yet its governance takes place without the rigour of overt practice but with a surveillance invisible so much so that invariably its status and authority on gendered difference remain obscured. Regulation is more covert than coercive, a practice of the monitorial school, as in Foucault's description of Bentham's dream of a panopticon (Foucault, 1977).

The place of the disciplining power of the official policy document, in understanding knowledges of the mind of girls, then becomes very important to our understanding of subjectivity and school mathematics. Who she is in school mathematics is constructed, positioned, and regulated according to the terms of the text. When we think of the official document in this way it is possible to see how it teaches powerful lessons about the gendered social world which are variously reinforced by the discourses and pedagogies of the family and the community. Considering *Mathematics in the New Zealand Curriculum* as an analyst and producer of cultural knowledge is to see it as a means through which socially constructed identity or subjectivity is made and remade. How the girl understands her location within a gendered identity in school mathematics is in part made possible through the symbolic meaning systems inscribed on the official curriculum document. It is through the text's language that cultural categories and versions of the

gendered schoolgirl are developed and established hierarchically (Davies, 1994) in the classroom so that the girl learns how to recognise, represent, and 'be' a girl in school mathematics.

This kind of interrogation is useful in that it demonstrates the historical and textual contingency of the girl in school mathematics. It reveals how power operates through knowledgeable discourses and practices, casting an educational gaze on the subject by ordering, measuring, categorising, normalising, and regulating her. However it tends to argue the case for the inevitability of the gendered learner, citing the fixity of the girl. To lay open a political imaginary for feminist practice requires that we take into account the surpassability of what history and the text give us to see how the real of the girl in school mathematics returns the gaze: how she reaffirms and/or contests these practices within the classroom. For Foucault the authority of a text like the curriculum statement is decentred from the author to the reader. That is to say that there is no fixed meaning in text. Thus with every reading and every moment of classroom practice the text is rewritten for the gendered learner. The text cannot determine, in any simple sense, how it will enter into the lives of particular girls in mathematics. It is to this investigation which the following chapter turns.

## CHAPTER SEVEN

## Lived Mathematical Experiences:
## Stories from Donna

> For a long time ordinary individuality - the everyday individuality of everybody - remained below the threshold of description. To be looked at, to be observed, described in detail, followed from day to day by uninterrupted writing, was a privilege. The chronicle of a man, the account of his life, his historiography, written as he lived out his life, formed part of the rituals of his power. The disciplinary methods reversed this relation, lowered the threshold of describable individuality, and made of this description a means of control and a method of domination. It is no longer a monument for future memory, but a document for possible use. (Foucault, 1984a, p203)

### Introduction

In the last chapter we looked at how the official mathematics curriculum document constructs and produces girls. Whilst that work provided important information, it was not, however, possible to develop a full understanding of what the text might mean in the lives of girls. In the following three chapters I want to examine the place of mathematics in the practices which, in their complexity, constitute the subjectivity of the three girls in my study. Drawing on the theoretical framework for exploring the constitution of subjects in practices as discussed earlier, I place the mathematical work of these girls within a larger exploration of the constitution of their subjectivity. What follows in this chapter, is my version of Donna's story.

The first time I met Donna she gave the immediate impression of a warm, generous and friendly young woman. Regarded by Mrs Southee as an "interesting" person, she was recommended to me because of her educational history of reading difficulties, difficulties which did not appear to surface in mathematics. She was very keen to participate in the research, stating later in her interview with me that she considered that, in the interests of her school, it was her responsibility to volunteer.

Donna is of medium height, and is distinguished by her long blonde hair which falls loosely from a large clip high on her head. She likes to surround herself with a wide circle of friends. As she says: "I just love being around people". As a fourth year student in Mrs Southee's class, Donna qualified to wear mufti to school. She was always dressed neatly in what I could surmise as the covert regulatory dress-code within the class - jeans and sweatshirt. She describes herself as "cheery and outgoing" and likes to be always busy: "I always want to have something to do. If I ever stop doing something it's when I'm sick or really totally bored so I've always got a project I've made up in the wings".

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I want to approach the story of Donna's mathematical experiences by exploring the complex intertextuality of the discourses and theoretical tensions which effect her life world. This approach will lead me to take an interpretive risk through looking beyond the stability of taken for granted practices. In narrating Donna's story I will be attending to a mix of discourses which, in their specificity, deny her any embodiment of stability in the complex dynamic which they wield. What I am interested in is exploring how these discourses are iterated and mediated, and how they position, reproduce and naturalise forms of logic and identity for her. How does Donna live these positions and these practices?

## Stories from home and early school

Donna's family is large. In her words: it is "like having two families under the same roof". Her own family consists of father, mother and two older brothers, one of whom has now left home. The other people who live with her are three very young foster children all of whom share the same birth mother. Donna's mother has cared for young foster children since she retired from her job as registered nurse a few years ago. Apart from noting added responsibilities within the household in the form of babysitting and helping with the evening meal, Donna rarely acknowledges the young children's presence. It is as if her own interests in Rock and Roll, Girls' Brigade, Sunday School and school music groups, are all consuming of her leisure time and attention.

Unlike most New Zealand teenagers, Donna has attended only two schools for her formal educational experiences. All New Zealand children on the day of their fifth birthday enter formalised schooling as new entrants. Typically for most students this school will be the local coeducational state primary school which will cater for them until they turn 10. At that stage most students proceed to the intermediate school for the next two years. Secondary education begins at about 13 years of age. Formal schooling for this student cohort are offered at either coeducational or single-sex institutions.

Donna attended only one school before beginning her secondary education. Her primary and intermediate schooling experiences were both provided by a private all-girls' day school, a school older than most in the city and one founded on Christian principles. The school is small (just over 100 students) and is located within the central business district of the city. Its tuition fees are high and hence it tends to attract the daughters of parents in the higher income bracket. But this is not the only socio-economic group drawn to the school: many of the school's families make considerable sacrifices to have their daughters educated here. This is how Donna recognises herself as a past student at the school:

> It was an excellent school. A good basis for education and it's like, it offers a lot. It's a small community school and I just thrived there. I loved it. You know everyone. It's safe. It's all girls so you don't have the distraction of guys to learn with. But on the other hand it's a disadvantage, like, with my form two class, half went to [one] school, and the other half went to [another] so I was the only one from my class, my year, to come away from everyone else.

What this school offered to Donna was a set of historically specific school-wide and classroom discursive practices. They were not the only discourses or practices operating at the time of her earlier formal education. But these were discourses to which she had access to within her early schooling experiences and which enabled her as a conscious thinking subject to give meaning to material classroom relations. To claim that they were powerful is to make a claim for the political strength of the interests which they represented, and the investments which Donna placed in them.

I want to look at those practices which organised Donna's early schooling experiences. I start by arguing that the construction of knowledge in this, and any, school involves discursive practices that traverse a range of texts and sites. What figures prominently at this school is that which has developed from theory and which does not dismiss feminine qualities as they are currently defined to be irrelevant and inferior. I am interested in the effect of this discourse on Donna, a discourse which stands in opposition to certain highly invested signs of femininity. In doing this I am not providing an analysis of socialisation, by which Donna is 'made social'. On the contrary, in Foucault's terms, Donna is inscribed and created and is able to manoeuvre within this specific discursive practice which she inhabits.

The discourse of which I am speaking theorises the female student in a way that pushes the naturalisation of female knowing to its conceptual limit. I have already argued at length in chapter 1 how the 'natural' exclusion of girls and women from mathematics is caught up with the traditions of binary thinking and Western scientific practice. In her subordinate position designated for her, marked as deficit or excluded, the schoolgirl has never emerged as the 'speaking subject' of school mathematics but has always been 'spoken for' or silenced by social and symbolic structures of exclusion. Her life which has historically differed in important ways from those of males, has tended to be ignored. The projection of men as the norm of all humanity has also contributed to her cultural

invisibility and social subordination by devaluing or ignoring her distinctive ways of knowing and living.

Donna's formative schooling experiences are couched around practices in reaction to this exclusionary discourse and to the concepts of gender identity and sexual difference which it normalises. This is not to suggest that this school figures as a trailblazer in asserting the educational rights of girls. On the contrary, New Zealand has a history of small independent educational institutions which have focused on girls' and women's ways of being and knowing (Middleton, 1987). Admittedly, in the early years the schooling ethos at such schools modelled the girl as nurturer, and facilitator to the more significant privately-educated male, destined for higher office. However more recent approaches to girls' private education have redirected thinking towards the establishment of a voice and a power for girls and women.

This discourse is quite at odds with the dominant body of literature of girls in mathematics, which I discussed in Chapter 2. Yet it does signal some points of convergence with the emergent feminist perspectives in mathematics education. I have already provided an analysis of the conditions of emergence of this revisionist discourse of girls. On the one hand this discourse marks out a new trajectory for the discipline. But on the other hand, the social realm is not witnessing anything new with the advent of this approach and it is precisely because of this that I want to explore in some detail what this discourse assumes and what issues these assumptions might raise.

Feminist reconstruction in mathematics education, guided by developments in Western feminist theory, is a recent project which reacts to established ways of Western binary thought. Working to escape from this logic, reconstruction proposals force some significant shifts in thinking about gender work. The claim is that our ways of thinking are inadequate for understanding our world because they subordinate, separate or devalue everything female. Reconstructionists criticise the Enlightenment's universal conception of knowledge privileging male interests and values, and argue that despite the intention of the Enlightenment tradition to advance human freedom, the concept of knowledge which it expresses has perpetuated the dominance of all things masculine.

A small but growing number of feminists in mathematics education (for example, Burton, 1995; Damarin, 1995; Becker, 1995), have defended some version of the 'standpoint' theory of knowledge. They propose that we focus on *difference* and ask that we view women's and girls' creativity in mathematics as something different from male approaches to the point where there could be no overlap between the two. Their attempt to reorder our ways of thinking draws on the critical insights of deconstruction into the

functioning of binary logic of western metaphysics. By this means they seek to expose the occlusion of girls from the mathematics discourse and their circumscription under an inherently masculine subjectivity. They maintain that these dualisms which we encounter in our daily life are not appropriate as they privilege the first term over the second, for example, man is prior to woman.

But their project is not simply to draw attention to the limits of binary logic. In its radical stance, the feminist reconstructionist position turns the tables on Cartesian thought by *reversing* the binary. The starting point is that the universe is not objectively knowable; rather it is the girl who constructs her world. The intent is for the individual girl to construct personally and socially viable theories of the ways in which the world works. In the feminist reconstruction 'voice' functions as a metaphor for the girls' self-expressions and girls are said to be empowered when they are facilitated by the teacher to release and give voice to their subjugated knowledges. Through the elevation of their personalised and localised knowledge, girls become the authors of their own mathematical world. Their self-definitions generate not only visibility but also are said to offer agency in terms of identity and position from which they might act for change.

Leone Burton (1995) in her chapter "Moving Towards a Feminist Epistemology of Mathematics" attempts to

> question the nature of the discipline in such a way that the result of such questioning is to open mathematics to the experience and the influence of members of as many different communities as possible. (p222)

Exposing the foundations upon which mathematics educational values were first erected, Burton, in her radical critique, draws heavily on the feminist literature on the philosophy of science to advance an account of the social world which is considered less partial and less distorted than the prevailing one. In arguing against the Enlightenment ideas of a duality between the knowing subject and the world, of the separation of cognition from affect and intuition, of fact and values, and of a logical linear notion of knowledge, Burton is attempting to produce a standpoint theory that better reflects the world than the incomplete and distorting accounts provided by traditional social theory. For her, and many others, knowledge is always produced from a specific social position, circumscribing particular interests, values, and beliefs.

Thus the starting point for Burton's new epistemology of mathematics is in the multiple character of social realities, and knowledge. Like earlier work in the field her reconstruction is discursively aligned with emancipatory ideals since it is grounded in a vision of social change. However her proposed theory of knowing is more answerable to social constructivism than feminism given that her understanding of women, men and

social relations in mathematics is not obtained exclusively from the perspective of women's activities. Her development is more a critique of the Enlightenment project premised on the rational thinking subject (in which mathematics plays a crucial part) than as a discourse spoken between women for women. Laying bare the social and political contexts which circumscribe the production of mathematical knowledge her analysis acknowledges the constitutive role these contexts play in the creation and validation of mathematical knowledge. As such her move towards a reconceptualisation of mathematics is more aligned with the *critical* project, than a feminist epistemological turn "which does justice to women" (Kaiser and Rogers, 1995, p8).

Burton's reconstruction promises much. Her work calls for the transformation of 'reality' through a voiced consciousness of the individual's social position. The pluralistic desire to make a space for diversity, which underwrites her move, is part of a growing presence among mathematics education's scholarly writing. Interpreted in this way Burton is arguing for the concept of *difference*. The argument proceeds from the presupposition that at any moment in history there are many subjugated knowledges that conflict with and are never reflected in the dominant stories a culture tells about its social life. These knowledges must be given expression.

A consideration of the philosophical foundations upon which the concept of difference has been shaped, unpacks an individual, disengaged from the world and the source of self-knowledge and of knowledge of the world. This individual has a defining quality which is projected onto the individual as, for example, woman, black, disabled, intellectually impaired, and so on. This whole set of alternatives operates with the underlying belief that everybody can find some definitive characteristic that constitutes themselves as learners in mathematics, and enables them to recognise in and with other identically situated learners. Proceeding from this is the idea of identity politics which argues that if individuals share some particular quality, then automatically interests, experiences and knowledges are also shared (Flax, 1990). The notion of objectivity underpinning the expression of shared subjugated knowledge assumes that the individual's perception of reality is to be trusted.

Damarin's (1995) project is an "attempt to begin a radical reorganization of the familiar ways of thinking about and interpreting issues and studies of gender and mathematics" (p242). Her purpose is to recover the place of women's and girls' exploitation in the discourse of mathematics and for her transcendence takes the function of making visible and, moreover, central, what has previously remained hidden - women's and girls' actual experiences and ways of knowing. In her chapter "Gender and Mathematics from a

Feminist Standpoint", she, like Burton, cites the literature of feminist scientists and juxtaposes this with Hartsock's (1983) work on standpoint feminism.

Damarin's standpoint theory is bound up with essentialism. Her individual relies on the liberal-humanist assumption that subjectivity is the coherent authentic source of the interpretation of the meaning of reality. This individual is conceptualised as in earlier notions, as a situated self, determined by social roles but, what distinguishes Damarin's position from earlier theorising in the field, is that the women's realities differ from those of men. Her identity must be renegotiated. It is important that the roles are reversed because 'female' experience is to be considered as the source of knowledge and the focus of learning. Damarin's approach begins in questions arising from the perspective of women's activities in which certain specific qualities are said to be 'naturally' female. In other words her standpoint theory rests on truth claims of the primacy of experience and consciousness. It is productive in the sense that it problematises earlier dominant mathematics education models of knowledge founded on Enlightenment ideas of knowledge, and in that it contests the presumption of a value-neutral, general knowing subject.

Becker (1995) defends the broad claim of gender dichotomy and takes this idea to another specificity, drawing on the authoritative textual discourse of Carol Gilligan (1982) to support her tentative conceptual proposal. Becker's approach retains a focus on the individual, rather than on relations, power and difference. It is produced by invoking the concept of difference in that women and men derive their significance through their difference from each other. Her argument revolves around the idea that women are connected knowers, and this connected knowing is made manifest by subjectivity, intuition, and a desire to maintain relationships. However she argues that neither male nor female preferred ways of knowing and working should be valorised one over the other. Her arguments for mathematics teaching and learning are tailored to intimate and familial processes, in which the notions of nurturing and trust figure as metaphors for exemplary teaching practice.

Becker's dichotomy between *separate knowing* and *connected knowing* occupies the identical theoretical space as the binary pair of Damarin's male experience/female experience, both relying on a biological base of difference. Both writers locate the question of girls' subjectivity within the hierarchical binary opposition man/woman to offer a 'bigendered' conception of the individual in mathematics. That is to say that in this logic the category 'girl' only makes sense in terms of a binary discourse on gender, in which girls and boys exhaust all possibilities of gender and relate to each other as complementary opposites. In this discourse the female learner has an essential core, an

essentialism which is on the one hand prior to the social field, pronouncing her autonomous, disembodied, coherent and stable, and on the other, inscribed in a masculinist construction of the individual. As a rational autonomous subject whose identity must be renegotiated she is the essence of individuality and that essence is located in biological difference. By fashioning the learner in this way the binary logic of Descartes' legacy remains intact.

This is the same rational autonomous subject which prefigured in Donna's earlier institutionalised schooling. Here she learned how to identify and name categories of similarity in identically situated learners: "You know everyone. It's safe". It was here that a classificatory grid is established for what counts as school excellence (it offers a lot, it's small), and how educational work is distributed on a gendered basis (girls at this school, *not* boys). These categories, in turn, are tied to the construction of differential power relations of gendered learning (boys' distractions ≠ successful learning; girls' expression of subjugated knowledge = success), whereby the parameters of what counts as successful girls' educational work are textually produced.

Donna's talk shows how the development of semantic resources for educational practice regarding similarity, difference, assessment and appraisal, is part of her articulation of the discourse of gendered learning. In these events of early schooling, we find a rehearsal of a gendered learning relationship and a representation and naming of categories of difference which together set themselves against those meanings established in the social world. In her interview she showed compliance to this version of standpoint feminism. Simultaneously she resisted it in part. This occurred when she found herself inserted into the coeducational learning practice around which her secondary school was organised:

> I think it's quite good [to have classes with boys] because in the work force there are guys and girls working together and you've got to learn to have relationships, relations, on a friendship basis with guys and know how to be around them. Like some, if you're not careful you could come out of [an all-girls' secondary school] with absolutely no social skills, besides being girlie and snobby *[laughs]*...I think it's really good having guys around. It's like, and they've also got different opinions than females.
> {interview}

Clearly, it is not the case that there are no discursive choices for Donna, but those choices are many and various and enmeshed in local practices and institutional constraints. The meanings that she derives from the choices are not produced at the rational level alone;

they are steeped in conscious and unconscious emotions, defences and habit. The identity papers she had acquired through her insertion into the revisionist discourse of her former school are challenged by and can scarcely be validated by the discursive practices upheld by her later educational institution. We cannot therefore separate her gendered experiences from the contradictory material and discursive practices which seek to regulate her gendered learning. It is too simplistic to categorise Donna as inconsistent and label her with any other derogatory term of our own choice. Terms like 'inconsistent' require deconstruction. Reconstructing consistency in the interests of feminism using poststructuralism is to argue for the complexity of the production of her subjectivity. This is what I have tried to explore.

Other discourses are brought to bear. In homework discussions with her parents in her earlier school years, Donna has learned powerful lessons about gendered subjectivity. For many years now, Donna has struggled with the reading process to the extent that in her School Certificate examinations she was assessed as requiring the assistance of a reader. Walkerdine's (1993) analyses of developmental theory have shown that whatever so-called cognitive impediments students might be seen to reveal, this has meaning only within the coding systems established by an over-arching discourse. In Donna's case her reading ability is referenced below the normative discourse, an under-par ability which is constructed in the official educational discourse and circulated through institutionalised schooling practices as 'learning deficit'.

Donna's identity at the school is mapped onto a complex grid of formal and informal educational discourses and practices. As she moves from one class to another curriculum subject, she moves out of and enters a new range of discourses and identities of the discipline which constitute her as a gendered subject for that discipline. In each of these classrooms, Donna enters into a politics of discourse. The identity positions and politics which these various discourses offer, differ significantly, from the mathematics classroom to the English tutorial, and to any other classroom subject options. They provide her with access to a differential engagement and positioning in discourse and to power. Labelled as she is as 'reading disabled', her positioning at school is not unambiguous. Her subjectivity, in Foucault's terms, is multidimensional and multidirectional, at once both powerful and powerless. Donna's parents structure their discourse of gendered learning for their daughter around the notion of normal development.

> My parents have really supported me in maths because it's the
> one subject that I can actually do. *[laughs]*

> My parents don't know anything about maths these days. All
> they had to learn were basics. *[laughs]* That's the plus, minus,
> divide, and times, sort of thing....They can't help me now.
> They say they just can't help me. I try to explain it to them. I
> end up telling them how to do it. *[laughs]* Actually teaching
> myself...
> {interview}

In the previous chapter we saw how the knowledge that this discourse of cognitive development produces becomes highly regulative; its developmental model assuming much importance in defining age-ability relation to learning. The approach assumes a direct link between certain learning behaviours and the age of students. The target of regulation is the deficit learner who does not meet the standards and requirements of the relation between age and ability. Donna's reading activities have been monitored and found to be wanting. At this crisis point a whole network of educational resources is put into action, one of which involves the family. Mindful of her differential capacities as established by the child-centred developmental discourse of normality, Donna's parents actively encourage her participation in a discipline which might well seem to them as realistic for their daughter, yet undoubtedly unrealisable for themselves personally.

## Stories from Year 12 mathematics

In this section, I am interested in understanding the relation of Year 12 mathematics to the production of Donna's subjectivity. In chapter 4 I sketched out my approach, and here I want to emphasise again that my concern is in analysing practices in order to understand how Donna is produced as a gendered subject in them. Mathematics enters familial practices obliquely; its entry into the mathematics classroom is much more pervasive. I have tried to show above that earlier mathematical experiences and the family do have some place in those practices, but now I want to explore Donna's life in Mrs Southee's classroom.

The place of girls, like Donna, in school mathematics has been contested and incurred intense debate precisely because it concerns the constructs of equality or difference. In the former view the question was whether women were the same as men, and if so, could this sameness be the only basis upon which equality could be claimed. In the latter position, the question circulates around the idea of difference, and whether difference could be used as an argument for equal treatment. By now it should be clear that there are problems with both positions and the circulatory logic within which they are both caught. In my view neither of these accounts deals with the complexity of the situation and thus

neither is able to engage with the complex issues surrounding the production of girls in mathematics. My interest is in understanding how girls are constructed and how they live and change themselves. This means that I need to question certain taken for granted assumptions of what girls are like in mathematics. In this questioning, the teacher figures prominently.

Donna's mathematics teacher, Mrs Southee, is a short, trim, and energetic woman who belied her years. She spoke in clipped English, demanding of her students that they express themselves coherently, and steered them away from resorting to colloquialisms or to slang. Calculus notation had to be correct from the start:

> I don't want to see anybody writing this sort of thing. That's a
> partial derivative. Please don't use this sort of 'd'. Use that sort.
> [pointing to whiteboard]. Some of you write fancy 'd's' like that.
> They look very nice but that means something entirely different.
> So we've got to get our notation right.
> {28 July}

She had been active in whole-school politics over the last two years as teacher representative on the Board of Trustees, a position to which she contributed much time and effort. Within the mathematics department she enjoyed the company of and intellectual stimulation from others. In all the years she had been employed at the school she had never actively pursued promotion nor career advancement within the department, content, instead, with her current position as 'assistant teacher'. Her classroom was maintained with care and pride, traditionally organised with pairs of desks in rows. Mathematics posters, daily notices of the school, and a small number of large travel postcards adorned its walls. These features in the room were part of a much larger ensemble of apparatuses regulating not only ways of behaving, but also ways of thinking. Foucault (1977) wrote of the way in which the emergence of "disciplinary power" haunts the school. He says:

> A certain significant generality moved between the least irregularity and the
> greatest crime: It was no longer the offence, the attack on the common
> interest, it was the departure from the norm, the anomaly; it was this that
> haunted the school...(p299).

Year 12, formerly known as the sixth form, had been Mrs Southee's responsibility for a number of years and this was to be the last as she had recently announced to the mathematics department she would be retiring at the end of the year after long service at the school. When I entered Mrs Southee's classroom for the first time as a researcher, I was taken by surprise at the sense of being immediately transported back into the student life-world in the classroom. What I felt then was precisely what I had felt from so many

years of multiple layers of knowing: the classroom size, its high windows, its whiteboard (once a chalkboard) and teacher's desk up the front, the rows of desks, the smells, the cupboards and bookcases. These were brought out of storage in the unconsciousness mind to point to a familiar pattern of classroom cultural logic, routine and action. What was more obvious to me now, however, and what, as a schoolgirl, I had never been able to articulate from the horizon of my thinking, was the pervasiveness of power: the way in which it "reaches into the very grain of individuals, touches their bodies and inserts itself into their action and attitudes, their discourse, learning processes and everyday [classroom] lives" (Foucault, 1980, p39). Technologies of domination shelved within my unconscious thoughts recalled the surveillance and panoptic control of the classroom.

The effects of power within the classroom on Donna are more subtle so that she takes for granted the rows of desks, the mathematics exercise work book in which she, like all the students, draws a red line down the middle before she proceeds with her work down one column, then the other. She fails to notice, as anything but usual for this classroom, the 20 or so minute whiteboard exposition given by Mrs Southee, in which students write frantically before she wipes her work off, and which is followed by a much longer interval during which students work at set examples. Nevertheless, certain issues of power and regulation confront Donna.

> Slow down! [laughs] Yea. Sort of rush, rush, rush, really. Sort of, you write down whatever's on the board but taking it in's a different story. You've really got to go home and do some exercises at home and work through it yourself. For me, anyway, to actually understand it, because this, you don't have time to do the exercises before she's rushing you onto something else. And if she's like, well, I've got a short attention span and it makes it even harder. And is she's babbling, and I'm trying to do something, I won't be able to understand it unless I try it out but then I'd probably miss out on what she actually says. I don't have time to do the work.
> {interview}

To explore this further I want to look at an early lesson {25 July} in which Mrs Southee is talking to the class about instantaneous rate of change. In this lesson she has been developing for twenty-five minutes an extensive investigation of this rate of change, presenting the results in tabular form. She asks the students to look for a pattern, saying: "We're not going to go through all this calculation any more. We're going to note the

pattern. How do we get the pattern?" After one volunteered answer and the short discussion which follows, she says:

> In other words, if we start off with y equals x to some power which we will call n - don't copy this down at the moment. I'm going to give you proper notes - then the instantaneous rate of change, which we are going to call y dashed, for a start - there are other notations too - is n times x to the power of n minus one. So whatever this number is, we put it in front and we reduce this by one. Would you pay attention at the back please? So this is a rule which you've got to learn. Now I'm going to generalise this and this morning's lesson is something which is very different from anything you've done before. So I'm going to do it slowly and I just want you to concentrate carefully. I want you to start off by writing the words: "We will now generalise the process we have been using".

Donna:        HONESTLY!

What can be taken from this? That Mrs Southee's treatment of the class is patronising? That this part of the lesson anticipates future difficulties or boredom? Is Donna's response to be understood as resistance? If this is so, Donna shows many other instances of resistance:

Donna:        We have to work it out I suppose. I have an idea. Answers in this thing?
              *[copies answers from the back of the book]*
              {22 July}


Mrs Southee:  ... The 'y' doesn't come into it at all. We simply use 'x'.
Donna:        Yea. It might help *[said cynically]*.
              {4 August}


Mrs Southee:  Yesterday I went through an exercise which was not easy. Some of you might have understood it. Some of you probably did not.
Donna:        NO!
              {28 July}


Mrs Southee:  ...of the reverse process....
Donna:        Reverse process? JOY! FUN!
Mrs Southee:  ...which is called antidifferentiation...
Donna:        Big words! *[sighs]*

Mrs Southee:    ...also known as integration.

Donna:          Integration? In, te,...

                {5 August}


Mrs Southee:    So it doesn't matter where it cuts the axis or anything like that. Nothing to
                do with intercepts on the axes. It's all to do with turning points.

Donna:          OK!

Mrs Southee:    I've put the dotted lines down for you.

Donna:          I bet that goes that way, and that goes that way.

                Doesn't take a heap of a lot of brain power to figure it out. *[said cynically]*

                {14 August}


In Mrs Southee's classroom backchatting is strictly impermissible. On one level it would be easy to say that Donna's talk represents a subversive act, bearing in mind the rules and regulations established in this classroom. However I think that position would mask the importance of what Donna is signalling. Central to this is the notion of autonomy. I want to suggest that the clandestine practice which is not quite audible enough for others to hear, and of which I have chosen merely a few excerpts from those which the tape records, is veiled by the safety net between classroom regulatory behaviour and oppositional processes. I want to suggest that this safety net obscures a questioning of what appears as natural and inevitable about student identity in the classroom. Moreover, I want to suggest that this safety net offers significant spaces for student agency and hides what has always been in the senior secondary school classroom - the exercising of critical judgment and the transgression of regulatory classroom practices by students.

On the one hand we could say that Donna is inserted into the practices of this classroom where she becomes the object of regulation and surveillance. In this sense her contextualisation is better understood as a repression of aspects of the many significations contained within *other* practices. But on the other hand, Donna's subjectivity is not constituted solely as the object of the teacher's gaze. Her subjectivity, like that of others, is created in a number of practices, and these are often competing, offering different opportunities and possibilities. I want to argue that private outwardly subversive talk provides a way for Donna to escape the confines of a model of proper girlhood contained in the psychoeducational discourses in which she is, as we have seen, already found wanting.

There were other ways in which Donna could be said to have explored the limits of her subjectivity. She sang in class. Indeed in almost every day of recording I have a reference to her ever-so-quiet singing. In the secondary school mathematics classroom,

singing is not a conventional practice. Indeed it is threatening to the educational project contained within New Zealand secondary schools, which operates with a fixed notion of student behaviour, unless its entry into the project is by means of a discourse of transgression. I want to look at the two types of instances, with just one example of each, which were particularly significant for me and which led me to think about the place of popular music in the production of her subjectivity. In the first Donna puts her mathematical thoughts to music. In the second she draws on the words of a song, which, at the time of the research, was in the charts of popular recordings.

Donna:          *[singing the words]* Three. I don't know. Why plus one?
                Oh, put one. Stupid thing! Of course.
                Oops. Three minus twelve, one over x squared.
                Equals x , three minus twelve...
                Six x squared plus c.
                [Number] five. Six, three, minus twelve, plus c.
                {13 August}

Donna:          ...That's twelve.
                Wahoo! I worked it out. Wahoo! I'm so happy.
                {4 August}

It took me some time before I realised the significance of 'wahoo'. Initially I thought that the word originated from Donna and it was not until I discussed the word with others that I discovered its origin in 'Song Two', by Blur. In this song the word is celebratory and it is this meaning which Donna has incorporated into her mathematical practice. In this way popular music is made to signify in mathematics.

In the earlier passage Donna she made up her own music to the lyrics that constitute her mathematics. It is not the case that she is drawing on the lyrics of a well-known song as an accompaniment for her mathematical work, but rather that her mathematical work *is* the song. This led me to reject the argument that her singing was a form of escapism or an act of resistance. I felt that any arguments made about Donna's singing had to be much more complex than this. Why should Donna take the risk of transgressing the limits of classroom practice? In order to understand this I want to suggest that Donna's mathematical work is a "work of art" (Foucault, 1984a. p350-1).

To develop this analysis I am looking at Donna's out-of-class interests, her designation as learning deficient in English, her previous success in mathematics and the investments

she has in making that success sustainable. In her interview with me Donna has told me of her interests:

> I've got Rock and Roll, and Girls' Brigade, and I help out with Sunday School and I lead the ISCF [International Student Christian Fellowship] here at [school]. I'm in the [school] Singers and I'm in the Concert Band. So. Yea! I keep myself busy! *[laughs]*

Singing and music are a big part of Donna's life. She tells me that the school's singing group meets every Wednesday and that the Band practises on Thursdays. In addition to these regular arrangements, both activities demand public performances which often require extra practices. She describes her interest in music and relates it to other areas of her school life by volunteering a link between music and mathematics: "Teachers actually say that maths is like music. 'Cos you can apply music to maths or maths to music." {interview} Mathematics is also extremely important in Donna's life. Its importance is related to the cultural capital it holds out for her as one of the few avenues open in her post-compulsory school options. "I really want to do well in maths 'cos it's the one subject that I can actually do, that I'm actually good at". {interview}

For Donna, mathematics is associated with the promise of a fulfilling career. On another level singing embodies emotional aspects of pleasure and it is those enriching, emotive aspects of singing that Donna allows into her mathematical practice. Here, singing is made to signify hope, of sidestepping the reading disability that continues to attach itself to her. To that end singing becomes the medium by which she unconsciously, or otherwise, engages with mathematics. However it is an engagement that takes into account the issue of surveillance, since Donna's singing is never heard by anyone else. In this sense Donna's singing in class cannot be considered rebellious; it is, rather, a strategy of promise. Given that such behaviour might ordinarily have repercussions in the classroom, it cannot be rendered here as pathological. Indeed it is my contention that singing for Donna is an empowering approach to mathematics..

## If You Minus in the Negatives You'll Get Further Back

In class Donna sits next to Brett. They occupy the two front desks next to the door, a positioning which occasionally requires one or other of them to answer the door when it jams because of a faulty locking mechanism. Neither seem to be bothered by this demand. Indeed they both take some small delight in being the momentary centre of classroom attention. My notes record that they always appear to be on-task, though as I

listened to Donna's tapes I learned that they occasionally talked about the School Ball, about an oncoming School Music trip, and about mutual school friends.

I have already argued that gender research has made great strides in understanding girls in school mathematics as part of the wider classroom and educational practices. Yet the knowledge that is produced from this body of work is regulative in that it tied up with what the generic girl does in the classroom. At a fundamental level, the dominant psychosocial approach in Western mathematics education research assumes a direct link between certain behaviours and mathematical learning. The assumption is that whatever actions the generic girl makes, and whatever feelings about mathematics she might have, these are cognitively related to her mathematical understanding.

Foucault's framework rejects the idea that there is any straightforward causal link between determining structures and the action of individuals. He criticises this tradition on two counts: the model of the essential human subject which it employs, and the discourses and practices which it projects and regulates about the individual. Classic studies in the field have no place, as we have seen, for unconscious processes and meanings. Thus while these studies might be able to talk about the girl in school mathematics in social and cultural terms, they are unable to speak of the girl with regard to the way she constructs herself within regulatory practices and technologies in Western societies. They cannot take into account the way in which Donna simultaneously is inscribed and refashions her classroom existence. In this section my concern is in describing and analysing particular classroom practices in which mathematics enters a relation for Donna.

In the classroom, mathematics is a social performance in which what counts as an authoritative interpretation of "Mathematics in the New Zealand Curriculum" is mediated by pedagogical interaction and teacher governance. Although we cannot claim that there is a straightforward causal chain between the text and the pedagogical process, that is not to say that there is complete disunity between the levels of action. Luke, DeCastell and Luke (1989) have argued that both teachers and students engage with, negotiate and contest the cultural logics of official school policy documents. How one 'does' mathematics, in this case, 'differentiation', is related in some important ways to the more general authoritarian systems of government in such a way that it is possible to understand how the authority of the teacher and the subordinance of students keys into more global hierarchical systems. The following excerpt exemplifies how what counts as differentiation is constructed by Mrs Southee with definitive moves, actions, and statements. She is differentiating $y = 2/\sqrt{x}$.

> We'll do 'y' is equal to one over square root of x. I mean, two
> over the square root of x. That's the same as two over x to the
> half. You did this earlier in the year in exponents work and we
> write that as two x to the negative half. It must be on the top line
> before we can start differentiating. Now we apply the rule so all
> we've done is to get it into a form in which we can differentiate.
> Get it into what we call a power form. Two times negative a half
> is negative one and this is x to the power negative three over
> two. Negative one and a half. Negative three over two...Right-
> oh. So we've got here minus x to the negative three over two. Or
> we can write that as being minus one over x to the power three
> over two in the bottom. And if we put it back into surd form,
> that's negative one over the square root of x all cubed, x cubed.
> That's another way of writing it.
> {30 July}

How one differentiates rational functions containing surds, as in this case, requires that students first apply the rules of exponents. These rules are extended to exclude the possibility of leaving the variable in the denominator. The variable must be brought up to the numerator before the process of polynomial differentiation can begin. After the rules of differentiation have been applied, the function is returned to its original form, using the rules of exponents. The mathematical logic assembled within Mrs Southee's discursive strategies, reads as follows: rational functions with surds - exponents - polynomial rule - exponents. It represents a set of claims about how differentiation should be carried out. For this class, a set of specific and ordered mathematical practices constitutes the very subjectivity of the student in this classroom.

The classroom is a relatively autonomous unit which has its own logic and specific history. Yet at the same time is has been "invested and annexed" by more "global [mechanisms of] domination".(Foucault, 1980, p99). The idea that this expresses is not to argue against the notion of agency. To understand this we need to think of the students' taking up of those instructional 'tools' as always relational. Clearly their activities are necessarily situated and constrained, but, as McNay (1992) argues, the determination of these activities cannot be subsumed under the logic of a single monolithic system. The student is neither the origin of social relations nor the passive product of an externally imposed system of social constraint. A mutual dependence of structure and agency exists, but this relationship is dynamic in the sense that the existing pedagogical structure is reproduced by both teacher and students even as they modify and change it.

Students, like all 'readers', makes sense of what is conveyed by attending to classroom convention but also to circumstance as well as to words and utterances (Clifford and Marcus, 1986). Any reading made is overdetermined by contingencies of language, rhetoric, power and history, to the extent that these work through students' interpretations in ways neither the policy writers, nor Mrs Southee, nor even the students themselves, can fully control. The following four passages give us some indication of the varying discourses, social relations, practices and student subjectivities that are possible within the genre of the mathematics class. The first is a discussion between Donna and Brett on the derivative of $y = 1/x^3$. After an brief exclamation at Brett's audacity to copy, the discussion revolves around finding the new exponent.

| Brett: | Can you move your book so I can copy? |
| Donna: | *[laughs in disbelief]* AH, EXCUSE ME! You shouldn't be copying! |
| Brett: | *[checking answers]* Negative four over three? |
| Donna: | Yep! |
| Brett: | How? |
| Donna: | Because that's a three, that's also negative three which is three over three. So just imagine that as negative one over three and minus three over three which equals four over three. |
| Brett: | One minus three is only two. |
| Donna: | OK. Do it on the calculator, It's NEGATIVE, 'cos, OK, a third negative minus three over three equals one and a third, which is four over three. |
| Brett: | Why? |
| Donna: | Because it's, it's, think of a, um, a time line. You are already in the negatives and if you MINUS in the NEGATIVES you'll get further back. |
| | {30 July} |

In the second excerpt Mrs Southee has been differentiating $y = \sqrt{x^5}$ for the class at the whiteboard:

| Brett: | How does she get to go from five over two to three over two? |
| Donna: | Because you've minused ONE WHOLE which is TWO OVER TWO. So in other words, you go five over two, minus two over two, equals three over two. |
| | {30 July} |

These two passages reveal how Donna assumes the role of what Walkerdine (1989) has termed 'sub-teacher'. She again takes up this position in the following:

Donna:              Um. Four minus three's one. And it's the change between the 'x'.
                    Um. That's cool. You're doing it right. *[to Brett]*
                    {23 July}

In addition to providing an understanding of how the teacher's discursive strategies provide a space for agency, and point to student subjectivity as non-unitary, these excerpts also address certain issues about the position of girls within the mathematics classroom. The following passage also looks at this positioning:

In this lesson Donna and Brett are finding the instantaneous rate of change at various points.

Donna:              Two point zero one squared. OH!
                    Yea, minus four.
                    Yea, that's just the 'y'. Why, yes, you ARE right!
Brett:              Of course I'm right. Was there any doubt?
Donna:*[giggles]*   YES!
                    I told...I MADE YOU DOUBT!
                    That is so funny! *[laughs]*
                    {23 July}

One view of the position of girls taken from the classic studies is that they ask fewer questions than boys, are called upon less frequently by their teachers, and are, overall, placed in a less powerful position than boys. Psychosocial models have tended to use constructs such as attribution, self-concept, role and attitude to account for girls as essential human subjects. Moreover, the discourses which have traditionally shaped her classroom peer interaction have prompted and sustained the idea of her as the passive and dependent product of a large-scale patriarchal system. Whilst such accounts have been important for the development of feminist interventionist practices, they do not adequately deal with subjectivity in which relations of power are continually mobile.

We have seen in Chapter 3 how Foucault takes issue with the view of power as a possession. The importance of this argument, and what is at stake here, is that the position of power as it relates to girls and boys in mathematics classrooms, as construed by classic studies, becomes problematic. The power relations which determine the role of the girl within the classroom are not simply microcosmic reflections of a more widespread, authoritarian patterns of governance. Rather, every positioning is determined by its own specific set of social forces and power relations. In Foucault's

terms the girl is able to become both powerful and powerless depending on the terms in which her subjectivity is constituted. Contrary to traditional research, she can be attributed with a certain degree of autonomy and independence in the way she acts, especially in the ordering of her day-to-day classroom existence.

The above excerpts stand in opposition to the idea of one-way subjection. From them, we are able to see that whilst Donna's practices are defined by the classroom and wider social context, by no means is she reducible to them. This argues for a more robust understanding of her subjectivity as *double-edged* - as constituted through practices of subjection and, in a more autonomous way, through practices of liberation. Here, it would have been easy to explain Donna's agency and self-determination in terms of 'freedom', in the form of a recovery of her authentic 'natural' self, as some theorists would have done. But that essentialist view is too simplistic because it fails to take into account how she actively and continually fashions her classroom existence through the adoption of various and sometimes contradictory practices. A more useful approach, as I have been at pains to suggest, is to look at the discourses at play.

Walkerdine (1990) has argued that young girls in the classroom are in a constant struggle with boys to define and redefine their play into discursive practices in which they can be powerful. If we examine the practices closely by looking at the turntaking rights in the dialogue, both Donna and Brett assume equal share, but it is Donna who controls the direction and length of the discussion. Clearly Donna's power has much to do with her access to knowledge of mathematical processes and meanings which are denied to Brett. In that respect her position as a girl in school mathematics has already been redefined for her, and allows her to avoid participating in any contestation of power. The discourse within which both Brett and Donna are operating is not about stereotypical arguments of dependent and oppressed girls but rather about mathematical knowledge as a powerful educational and social acquisition. What is important here, is that the category 'female' is not necessarily a less powerful category in school mathematics than the category 'male'. Its meaning is derived from within the discourse in which it is used.

## I'm so Blonde

This is not to argue that Donna will necessarily be powerful within the classroom in all her social interactions with Brett. Discourses vie for position, offering Donna competing ways of organising and giving meaning to her mathematical work. In doing so, they offer her a wide range of subjectivity modes. Some of these discourses will seem to her, at any one time, more powerful than others. Some will validate the status quo; others will contest the taken-for-granted, and the particular interests which they represents (Weedon,

1987). On some occasions these competing discourses will operate simultaneously. In the following excerpts, on the surface, it is difficult to grasp what is going on, and a simple explanation would draw on the notion of irrationality. A more productive approach is to look at the competing discourses at work.

1.    Donna and Brett are working on finding the derivative of $y = 1/(2x^4)$. Donna has worked out the answer correctly as $y' = -2x^{-5}$.

| | |
|---|---|
| Brett: | How did you get that then? |
| Donna: | A woman's prerogative! *[giggles]* |
| Brett: | Seriously, how did you get it? |
| Donna: | Can't remember. No, I can't.*[giggles]* |
| | {29 July} |

2.    Donna and Brett are working independently on finding the derived function of $y=3x^3$.
      Donna checks the answer as $9x^2$.

| | |
|---|---|
| Donna: | Why is that squared? |
| | Oh, I know why! I'm so blonde. |
| | No, I'm not. I get it! |
| | *[to Brett]* Did you get it? Did you do that? |
| | Bet you didn't! |
| Brett: | Shouldn't that be a 'three'? |
| Donna: | No, 'cos, I know with those ones there, you've got to bring that down one. So it's nine x squared. So I've got it right, now. |
| | {28 July} |

3.    Donna is working on differentiating $y = 3/(2x^5)$

| | |
|---|---|
| Mrs Southee:*[to class]* | X to the power negative two is one over x squared. Are you all happy about this? If you have one over 'a' to the power negative three, it's the same as 'a' cubed. If you have one over 'm' to the power... |
| Donna: *[whispers]* | X, five, that's negative, isn't it? And that's negative. |
| | Makes that a negative, so that's three over two. So that's negative four. |
| | Fifteen over two, x, negative four. |
| | [checks answers] Mmmm? What? Ugh? |

I'm so blonde! Why this, that becomes negative, dum, dum, dum, dum, dum, dum *[sings this to the tune "Deck the Halls with Bells of Holly"]*
OK. START AGAIN!
{30 July}

4.      Donna is working on finding the gradient of the tangent to the curve $y = 1/x^3$ at the point (-1, -1).

Donna: *[to Mrs Southee close by]*

|  |  |
|---|---|
|  | I don't get number eight |
| Mrs Southee: | Number eight? Right-oh. How do you differentiate that? |
| Donna: | You bring this up to the line. |
| Mrs Southee: | Which of course is x to the negative three. So, the derivative is negative three x to the negative four. 'N' x to the minus one. OK? Which is negative three over x to the fourth. So the gradient of the tangent, at what point? Negative one, negative one. So negative one is negative three over negative one to the fourth. |
| Donna: | Oh! Ok. *[Mrs Southee moves away]* How blonde can you get! |

There are traces here of what Davies (1998) calls "bumping" (p138) discourses, which have the effect of confusing meanings, and blurring male-female category memberships. What it means for Donna to be female in this classroom depends on the discourse claiming her attention at any one moment, yet clearly in the above passages those discourses overlap and bump into each. Donna talks of a "woman's prerogative" and "blonde". These were not the only occasions in which she spoke of being "blonde". She did in fact use the word many other times during the research. As it appears above "blonde" is juxtaposed against a clear demonstration of her full insertion into the processes of differentiation in mathematics. We can glean from the sense in which she uses these words that this is not some aside reference to the colour of her own hair, but that she is reproducing and legitimising certain dominant cultural forms of femininity.

Luke (1996) has argued that from infancy, girls are immersed in and come to learn the cultural patterns through which dominance and subordination are achieved. Popular culture plays a part in framing their understanding of the world and of themselves, of gender relations and cultural symbols, values and social power. To that end, cultural and media representations enable learning about gender to take place. The ways in which girls negotiate and experience the messages of cultural texts is crucial to any

understanding of subjectivity as produced with regimes of truth. One public discourse of gender played out in the images of television, magazines and advertising, is that of the 'dumb, blonde (yet alluring) female', epitomised most expressly in the film industry's construction and presentation of Marilyn Monroe, more recently subverted by Madonna.

How do we read Donna's private talk? In listening to the tapes over and over, I became more and more convinced that Donna easily 'took up the tools' of the discursive practices of how to 'do' mathematics operating and sanctioned within the classroom. She exercised a form of self-policing by checking her answers against the solutions given in the question and answer booklet. Correct answers were sanctioned from within the discourse itself. However any evidence of incorrect or uncertain work resulted in an immediate uptake of a discursive production of femininity, organised around notions of lack, inferiority, affect and unreason. But these are simply momentarily slippages and might be better read as token gestures to cultural definitions of femininity to which Donna herself was never willing to submit.

## Conclusion

To the public world of the mathematics classroom Donna presents as obedient and capable. Her audio-taping opened up a world that was not visible to me before and called attention to the unmarked and obscured in a number of ways. Through a poststructural analysis I was able to extend this capacity in order to grasp how gender is created and sustained within the classroom, within what power relations, and with what effects on Donna. I set this against the truths held by the current cultural representations of the category 'female' and psychoeducational accounts of the girl in mathematics, which, I claim, do not engage with the specificity of girls' lives. My endeavour was to produce an account which does not universalise and normalise Donna's position in mathematics but which demonstrates how she lives out contradictions and how they operate in the limited terrain of self-production which is open to her. Inside all of this I have tried to place an understanding of unconscious meanings and processes and their place as a central organiser in Donna's mathematical work.

## CHAPTER EIGHT:

## Lived Mathematical Experiences:
## Stories from Amanda

> I am interested...in the way in which the subject constitutes himself in an active fashion, by the practices of self, these practices are nevertheless not something that the individual invents by himself. They are patterns that he finds in his culture and which are proposed, suggested and imposed on him by his culture, his society and his social group. (Foucault, 1988a, p11)

### Introduction

Amanda was the first student of whom Mrs Southee made reference to me as a possible research participant. She was not an extension student; nor was she seen to be struggling with mathematics. It was her quiet, well-behaved manner and the neat and tidy work she produced that earned her Mrs Southee's recommendation. A hard worker who never created any trouble, Amanda has the characteristics and disposition which leads Mrs Southee to name her as a "model student".

Amanda is of short to medium height and average build. Distinguished by her freckled complexion and long light-ginger coloured hair, usually held back by a single plait, she, like Donna, conforms to the unstated dress code of the class by wearing tidy jeans and sweatshirt. In her interview with me she describes herself as a "quiet sort of person. I enjoy doing new things and stuff, but I'm not really that outgoing". This is reiterated by her teachers who read her as a shy and private individual. This is a perception gleaned from her apparent reluctance to contribute to or to ask questions in classroom discussions. The field notes of my observations noted her silence. I began to wonder if she would have anything to say to my project.

My story here of Amanda is concerned with the given and possible realities of classroom existence. It draws on Foucault's (1984a) idea of analysis as a concern with "linking together as tightly as possible the historical and theoretical analysis of power relations, institutions, and knowledge, to the movements, critiques, and experiences that call them into question in reality" (p374). For Foucault, two simultaneous dimensions of social life exist: the given and the possible. These two dimensions become accessible to us when specific events, circumstances, and dilemmas are viewed from different perspectives. I want to place the persuasive cultural myth of the quiet diligent girl in mathematics alongside a view that reveals entirely new structural formations of her classroom existence. In describing and working through Amanda's mathematical

practices, I offer an analysis that might go some way to reconceptualise her practices in ways that assist in rethinking the story of girls in school mathematics.

## Stories from home and early school

Amanda is the elder of two daughters to a one-time fashion designer mother and a father who works as a mechanic. The number of people in the household grows during term time to include other young students. At the time of the research both a young woman boarder, studying at the local university, and a female Japanese secondary school student participating in an international student exchange programme, were living with the family. The family was also awaiting the arrival of another short-term exchange student from Germany, and Amanda anticipated a reciprocal living arrangement with that student's family for herself the following year. Household space for the family was sacrificed and a mechanic's income met these expenses with the expectation that foreign students would contribute to the enrichment of life and provide post-school opportunities for the daughters in the family.

It is in this female-dominated household, with its ensemble of cultures, which Amanda spends her leisure time. Music is a significant part of family life since both Amanda and her sister both "do lots of music", practising what they have learned in their music lessons at school and through which Amanda has developed some expertise in piano and flute. Not much television is watched in the household, apart from the News and documentaries. Amanda's primary and immediate education years had been spent in a neighbouring city. That the family cared deeply about their daughters' education is beyond question. Whilst the first years of schooling were spent at a local coeducational state primary school, the last three (Years 6-8) saw her enrolled at a private Christian-based school catering for girls and boys. At that time the school catered for students only at those levels. Amanda expresses her opinions on this school in global terms of enjoyment and rating: "I really enjoyed it. It was really good". But what is clear is that she appreciated the school had extended her mathematically, placing her in a strong position for her Year 9 class: "A lot of the maths we did in third form [Year 9] I'd already done in form 1 and 2 [Years 7 and 8], so I was re-doing things but I suppose that was quite good. Revising everything."

Within this context, in which the parents' self-sacrifice plays an important role, order and control are high on the agenda. This authoritative familial discourse is persuasive and is taken up by Amanda. Indeed it would be difficult for her to behave other than in an orderly and controlled manner when so much had been invested into her education: "[I'm a] pretty organised person. If my room's messy, it's a tidy mess. I know where

everything is, even if it is messy. If it's out of place, it's a tidy out of place". Lessons from home had taught Amanda the importance of doing the right thing, not only when others were watching, but also when they were not. Indeed, it could be said that the exercise of self-vigilance is fundamental to the family's behaviour and practice. Amanda fitted neatly into this scheme of things and presented as the quiet, shy, good girl her average-income parents expected and recognised.

## Stories from Year 12 Mathematics

In this section I describe and analyse the classroom practices in which mathematics enters as a relation in the process of subjectivity. The mathematics classroom is central to this analysis, not at the level of classroom dynamics and pedagogical practice per se, but as a site where certain meanings, and not others, can be made. My interest is not in any able/learning-deficient discussion, nor in the rational/emotional debate, but rather in understanding how Amanda produces a narrative of her successes, her difficulties, her hopes, and her frustrations in mathematical work. My hope is that I can identify what informs her notion of learning mathematics when essentialist notions of common sense knowledge of girls in school mathematics seek to subvert her efforts to learn. What sense of the real does she construct to legitimate her own efforts? What images of knowledge, experience and authority work through her practices in and beliefs about mathematics learning?

The conventional way of looking at Amanda's mathematical work would utilise a developmental model. Within the terms of stages of development, Amanda would make clear certain understandings with the mathematics official text. Given that the meanings Amanda makes are important to this analysis in hand, they are however not shaped by the terms of developmental stages. Nor are they merely the result of some searching into the psychological depths of her knowing, into the emotional domain. The point I am at pains to make is that these understandings are produced in part within the complex history of the classroom in which she is already inscribed, and by which her very actions, needs and desires are made to signify. What is crucial here is that, on the one hand, developmental models sidestep the issue of the unconscious altogether. On the other hand, whilst the emotional domain is tantamount to psychosocial accounts, nevertheless this perspective fails to link this interest with mathematics itself. In *that* account, mathematics is first and foremost a vehicle for the demonstration of feelings, attributions and so on, and around which a classification is able to be made.

This is how Amanda describes her mathematical practice to me:

1          During the lesson I usually listen and when she's [Mrs
          Southee] finished, I write everything down that she's done.
          Otherwise I'm writing and listening at the same time and it's
          sort of..., it's not really..., I don't really understand it totally.
5          [I] just watch. Like, if she's writing while she's explaining, I
          watch what she's doing and when you're...Write it down.
          And when you're by yourself, just go through it again. Don't
          just copy it straight down; just take your time writing it.
          Sometimes it might mean that you're behind someone else who
10         has been busy writing it down as the teacher has been talking.
          But that doesn't matter.

From the perspective of discourse analysis, Amanda provides a metatextual commentary on a pedagogic event fundamental to the mathematics classroom: how one does mathematics. She orchestrates a relationship between mathematics and the student in which the learner is to 'watch', then 'write it down' and later 'go through it again'. Lines 1-7 mark out that logic. In this logic, one moves reflexively from the teacher's talk to the writing and back to the remembered talk, grounding interpretation through the process of writing. In this way, teacher talk, the learner, and mathematical knowledge are linked. But the narrative account is not constrained to establishing connections: it also anticipates and responds to a hypothetical contrary argument made explicit in Line 9: 'Sometimes it might mean that you're behind someone else...' The payoff of Amanda's approach consists of a refutation of this oppositional position in her decisive statement 'But that doesn't matter'.

Developing this analysis further, in Line 1 Amanda outlines the subject position taken by introducing the first person pronoun 'I'. A shift occurs in Lines 5-7 from 'I' to a pronominalisation 'you', signalling a move from a personalised account to the construction of a learning position that is more general and diffuse in its specificity. The implied imperative 'you' in 'don't just copy it straight down; just take your time writing it' positions her as an authoritative 'learning strategist', identifying, focusing on, and providing answers to the question of learning. These shifts mark out and position the implied 'other students', in solidarity with her personalised 'watch then act' approach. Thus within the structure of Amanda's talk is an implicit understanding of how to conduct pedagogical relations around the text. In effect, her narrative, like many educational texts, is constituting an identity and a set of textual, institutional and social relations for the learner in her classroom. The learner is situated within a particular view of pedagogy, to read the classroom world of mathematics from a particular epistemological vantage point.

Amanda's ideational field of learning establishes benchmarks for what counts as 'doing mathematics' and 'being a learner' that might extend beyond the parameters of Mrs Southee's classroom. Extending this idea, and drawing on Foucault's thought and on my observations of other mathematics classrooms in this school, 'doing mathematics' here complies with an institutionally mediated and sanctioned reading of school mathematics. Thus it provides evidence of specific disciplining practices that shape learners in mathematics, authorising some particular knowledge-power relationships at the expense of others. That regime of truth marks out the conceptual and material limits of possible learner subject positions and textual practices available within this particular community. It shapes difference.

The difference that it shapes is not in the sense of gendered difference but in terms of excluding other practices. It is true that the discourse fails to make any explicit reference to gender, implicitly arguing that girls, like boys, can become authoritative learners in this classroom. My point here is that, despite the fact that 'gendering' is not visible does not prevent a discussion of other processes. This is precisely because, as Davies (1994) has argued, gender is not constituted independently of other processes, and hence those processes must be foregrounded as part of the context in which the girl in school mathematics can be understood.

## The Engagement of Complex Mathematical Work

My original fears about Amanda's silence in the classroom were not unfounded. When I read through her transcripts it appeared that there would be little to say about her in the mathematics classroom since entire lessons were devoid of peer interaction and private talk. Yet a closer reading, searching for the patterns of power and powerlessness that are silently spoken into existence, revealed a narrative which is quite unlike that which is initially apparent. In this section I want to explore that other story. I am interested in the classroom as a strategic site and set of practices in which femininity and masculinity are constructed and sustained as relational categories of unequal meanings and sets of power relations.

Amanda routinely sits next to Maire, a Japanese exchange student, neither girl engaging in conversation to any significant level. When they do talk the discussion centres on assessment tasks and achievements concerning the next Unit Standards test, a national assessment procedure administered by the New Zealand Qualifications Authority for the Ministry of Education. In her interview with me, Amanda says:

> I want to pass as many of the Unit Standards as I can and if I
> don't, hopefully, I'll do well enough to carry on next year. [I'd
> like to] probably do well on the algebra because I've been
> struggling a little bit in that and I've been going to the support
> maths to hopefully do better in that.

To help improve her chances of taking mathematics next year Amanda has been attending a weekly support class after school time, organised and staffed by the mathematics department at the school. These extra classes taken in the teachers' own time are both voluntary and compulsory: voluntary in the sense that students may choose to attend in order to improve their grades; and compulsory in that attendance at them is a prerequisite for the opportunity of resitting the assessment tasks. Amanda describes these classes, though not in these terms, as a supportive learning environment, with an emphasis on collaboration, cooperative learning, inquiry and problem solving. These are the terms that characterise a constructivist mathematical practice.

The constructivist practice of active and supported involvement mapped out implicitly in "Mathematics in the New Zealand Curriculum" for New Zealand mathematics classrooms is considered fundamental to the construction of personal knowledge by students. As I discussed in chapter 6, constructivism, as a theory of how we come to know in mathematics education, gives priority of place to the perceiving and acting student whose personal constructions will, through social interaction, lead to cognitive truth. The teacher's role is to facilitate and empower rather than signify as the authoritative validator of thinking. Thus the teacher is expected to "provide the setting, pose the challenges, and offer the support that will encourage mathematical construction" (Davis, Maher & Noddings, 1990, p3), knowing when to intervene and when not to interfere. Wood, Cobb and Yackel (1995) stress whole class discussions and small group collaborations, noting the importance of making opportunities available for the learners' explanations and justifications. Thus the terms of the discourse, such as support, collaboration, personal knowledge, take their meaning from the position and function they hold within the constructivist discourse.

I am interested in what it means for Amanda to be positioned and subjected in this discourse. To develop a poststructuralist analysis of her as a gendered subject, I want to investigate and make visible the detail of how her specificity is put into place and maintained. I am also interested in how she lives the contradictory positions created within constructivist practice and how these effect the production of her subjectivity.

In the traditional mathematics classroom authority relations give the teacher certain power over knowledge to which students endeavour to gain access. Constructivist notions of learning ask that the teacher de-emphasise that knowledge and locate pedagogical practice within students' knowledges. This presents a dilemma for Mrs Southee who has always been more than willing to share her mathematical knowledge, and is recognised within the school in the terms of "universal intellectual" (Foucault 1984a, p68) as one who speaks in the capacity of master of truth by providing the answers and problem solutions. Now she is asked to give her students access to a new range of possibilities and opportunities so that they might construct mathematical knowledge for themselves.

The class has been working on finding the equation of a curve when given the gradient function and a point on the curve. In what appears as a closely scripted strategy of prescriptive moves, Mrs Southee has spent the previous ten minutes doing five problems on the board. Her practice is monologic in that teacher initiation and exposition leaves little space for sequential student questioning and teacher feedback. Divergent thinking, conjecture, exploration and investigation on the student's part are not actively encouraged. The class begins working at set problems from work booklets. Amanda is puzzling over finding the equation of a curve at the point $(0,0)$ whose gradient function is $y' = 3x^2 - 3x$.

Mrs Southee: *[near Amanda]* All right?

Amanda:          Is that right? *[she has written $y = 3/2x^3 - 9/2x^2 + c$]*

Mrs Southee:   The other bit of information you are told is that x equals zero and y equals zero at the same time. So we are going to substitute zero, zero, and we'll get zero equals zero minus zero plus c. So c must equal zero. So hence, when y is equal to three over two x cubed, it is, no, sorry, three times this will be a third x cubed. You're integrating. Minus three times a half x squared. So it will be x cubed minus three over two x squared.
*[$y = x^3 - 3/2x^2$]*

Amanda:          Mm. Must copy that down.

                     {8 August}

Twelve minutes later Amanda is checking her answer to another problem of finding the equation of a curve at $(-2, 0)$ when the derived function is $y' = 6x^2 - 5x - 25$

1       Amanda:        Oh! Oops! That's wrong!

         Mrs Southee: *[overhears]* What's wrong here? You've got six times a third is two, isn't it? Um. Six x squared plus 15, minus five x. That's right. Minus 25. Good. So it will be six times. That's correct. So that

5                  will be two, so y is equal to two x cubed minus five over two x
                   squared minus 25x.

$[y = 2x^3 - 5/2x^2 - 25x + c]$

*[Reads Amanda's answer]* And c is plus 25? Are you
substituting the right way round?

10               *[checking]* That's correct.
                   Y equals zero, x is negative two. That's right.
                   That will be 16.

Amanda:        Oh!

Mrs Southee:   And that will be plus ten. NO. That will be MINUS ten. That's
15               correct.

Amanda:        And that's...I, I squared it, ...plus...

Mrs Southee:   You squared it? That will be plus fifty, plus c. That gives you
                   zero.
                   What's that now? Six, no, 26, 50 minus 26, is 24. Minus 24.
20               Sorry, PLUS 24. So c is negative 24. OK?
                   {8 August}

In these passages, Mrs Southee is engaged in quite complex mathematical work with Amanda. When I first listened to this tape I had some difficulty making sense of what was going on in the second excerpt. Where did the "plus 15" [Line 3] appear from? In addition the statements "So it will be six times. That's correct. So that will be two..." [Lines 4-5] seemed to be contradictory. "Six, no 26, 50 minus 26, is 24" did not exemplify the rationally ordered practice that I knew mathematics to be - the discourse in which I expected to be inserted. That fact that my recording of Mrs Southee here reveals a very confident 'authoritative' voice (and, simultaneously, a very tentative Amanda) only exacerbated my dilemma. Only later when I was engaging again with the transcript of this interaction could I see through my problem. The power behind Mrs Southee's words is obviously not the same power that binds the rational structure of mathematics together. Conceptual leaps within the spoken language, linking terms and ideas together in structures which I had difficulty decoding, denied me access to the rational discourse familiar to me.

## Relevancies for Pedagogical Practice

Positioned differently in a discourse of school mathematics radically changed from the ideals and values which guided her previous teaching practice, Mrs Southee faces the problem of creating particular forms of knowing that demand a commitment to equity and justice for all students. She reads her past teaching practices as having relevance for the

key assumptions, goals, and pedagogical practices fundamental to "Mathematics in the New Zealand Curriculum". But they are not the only relevancies. As someone highly invested in the 'individual needs' discourse, particularly as it related to girls, the official curriculum signifies for Mrs Southee a different set of storylines about what it means to teach mathematics in New Zealand classrooms. For her it means a renegotiated attention to socially disempowered and disenfranchised others, that is, *girls,* and to the 'provision of opportunities' that might 'enable' them to take control of their mathematical lives. I understood her interest as founded on a naturalised view of the origins of gender difference between male and female.

For Foucault, knowledge, including mathematical knowledge, is implicated not only in the practices of administration and normalisation, but also in the production of forms of sociality. The position of teacher does not give Mrs Southee to power to choose what mathematics will be taught to her class, but it does give her access to another powerful platform - that of a choice of processes to use to establish its authoritative discourses into her classroom. That transformation is dependent on her general commitment to all learners and can be read from the 'progressive ideals' discourse of liberal humanism, and also from her particular feminist focus on girls - her belief that girls should have the same rights and opportunities as those enjoyed by boys.

Rereading the excerpts above, it is not readily apparent how these progressive strategies are enacted. It is my contention that classroom authority relations become central to the process. At the beginning of the lesson Mrs Southee demonstrates the conventional and 'correct' way of finding the equation of a curve when given specific information. She requires her students to construct the mathematical knowledge which *she* deems appropriate, leaving no space for the construction of personal knowledges. In this sense her practice at the whiteboard can be read as viewing mathematical constructs as possessions which she holds and to which they, her students, should aspire. Student agency and autonomy are located within the individual.

Speaking from her position of hierarchical privilege within the classroom Mrs Southee positions herself as the ultimate arbiter of authoritative and absolute knowledge and her students as universal, unitary and essential. Simultaneously she endeavours to provide the supportive, nurturing and caring environment that she equates with social justice. Her liberal-humanist model of education which valorises the Enlightenment ideal of progressive growth, plays out as she moves around the classroom after her whole-class demonstration, making herself available to assist all students on their request.

## Looking at the Issue of Silence

I want to return at this point to the second of the last two excepts above. I wondered what the implications for teaching might be here. If I was floundering with the logic, what sense might Amanda make of it? In this interaction it is clear that Mrs Southee is taken as the guardian of mathematics truths since she holds the authoritative knowledge. Looking at the transcript I have no way of knowing how Amanda engages with the ideas, patterns and relationships presented to her in this particular lesson, because she remains totally silent after Mrs Southee has moved away. Engagement, as Threadgold (1996) argues, can only be intimated from a demonstration: in this case one that shows that Amanda has learned to embody, perform and enact not only the genres that constitute the theories and practices of mathematics, but also the genres of social relations that construct mathematics as a discipline.

Silence is never as unproblematic as it might seem. I want to pick up on the idea of silence here and suggest that there are, in Amanda's classroom practice, other less readily visible arguments to be made. The first point to note is that it is Mrs Southee who is responding to an implied request for assistance from Amanda. When I compared the frequency of Mrs Southee's interactional work with Donna, in the previous chapter, and with Rachel in the following chapter, Amanda by far received more attention. Why could this be so? Looking for further detail from Amanda's transcripts revealed that although Amanda rarely spoke to her peers in class, she was not totally silent.

I want to take up this observation and examine its place in the narrative of the classroom life of Amanda. Unspoken and unanalysed elements exist in many authoritative arguments about girls in school mathematics and they must be unpacked. These are to do with power and oppression, and with hopes and desires. At the same time those elements that are spoken of and validated have to be understood as contributing to the conditions of the girl's subjectivity and to her possible resistance to it. By making visible the way in which mathematics as a discourse comprises close and complex relationships of power and knowledge, it will be possible to show how the spoken and the unspoken become intricately linked to subjectivity.

Historically, surveillance can be seen to have entered the classroom and found the girl's mathematical practices wanting. Interest in this area involved an extensive engagement with the processes and outcomes of school mathematics in which girls' achievement, learning style, approaches, classroom time and attributions, and involved exposing gender inequalities. As I noted in Chapter 2, the girl's curricular visibility was examined, and her options and career choices were monitored. On the basis of her absence and

deficiency, proposals were made and reports written, finding their way into educational polices and curricula. One of the targets of regulation in school mathematics, then, is the girl, and there is no place outside this paradigm to consider her in any terms other than in a model of normality/pathology.

At first sight Amanda's mathematical practice could be understood as pathological. She is passive and does not engage powerfully because she does not speak or reveal mathematics 'truths'; nor does she engage in the 'correct' processes. In *this* discourse she is constructed in the binary divisions teacher/student, or correct/incorrect, where the first term takes precedence over the first. It is true that this is not the only discourse in which Amanda is pathologised. What is important for me is her positioning in the binary division boy/girl and the place and significance over the meaning of femininity - how she uses and makes sense of the construct in the context of her daily mathematical practice and relations within the classroom.

In Chapter 1, historicising the political, scientific and economic contexts, I noted how select significations of femininity gained power and appeal among the institutions of mathematics education. Early meanings privileged domesticity, and tended to romanticise young women's culture, denying her power or place within mathematics. Celebrated accounts of feminine excellence in mathematics were considered 'oppositional' or 'exceptional' practice. Such accounts failed to acknowledge how these instances could be significations within a specific set of asymmetric and unequal power relationships between men and women.

Over more recent years the psychoeducational discourse has naturalised specific forms of girls' subordination, investing in particular discursive codes of femininity which shape how girls should act and behave individually and collectively. Precisely because this construction of the girl is powerful, attempts to change the behaviour of the girl must contend with a set of discursive impediments. Walkerdine (1989) has shown how Cartesian thought in child-centred education takes as its starting point the rationale of the developing male child. The girl is defined by the very qualities that are in contrast to those of the boy, who is cast as a figure who is active, inquiring and shows real ability. She is good, well-behaved, and silent and her naturalised femininity which is antithetical to reasoning, exists covertly alongside that of boys.

Amanda presents to the classroom the face of the hard-working diligent female student, in which, while pathologised, is still desired. Most of my research notes record her as fully compliant with Western discursive codes of femininity and sustaining those conventions by routinely carrying out gender "category maintenance work" (Davies,

1997, p12). Amanda prided herself on being well-behaved. I identified strongly with that which is precisely why I want to speak on her behalf. Yet in that sense it is difficult for me to look more impartially at her classroom practice. As researcher in the classroom I envisaged myself as the nice, kind girl in Mrs Southee's classroom, the way I used to be in my own mathematics classroom many years ago. My school life history had particular relevance for what I observed and recorded. As I sat in Mrs Southee's classroom I recalled how I too had gone to great lengths to be seen not only as 'the model student', always deferring to the teacher's authority, but also to be considered as 'good at maths' in my own teacher's gaze. That is why I often asked questions that puzzled me, not daring to in front of the whole class, but rather in that closer interactional work that sometimes comes from individual student/teacher encounters.

In reading Mrs Southee's 'model student' discourse correctly, Amanda has learned what it means to be empowered in this classroom. And it is precisely through reference to Amanda's quiet, well-behaved manner that Mrs Southee is able to justify all the attention she gives to her: she is seen to be deserving. I want to suggest that another face of femininity is also discernible, for there are other discourses in which Amanda is constructed in this classroom in which she is no longer positioned as passive, weak and silent. In relation to the other students in this classroom, Amanda is in a very powerful position. She can receive her teacher's approving gaze by being silent. Simultaneously, she has also learned that she can prompt this attention by positioning herself as in need of mathematical support and help. In this way she is able to sustain her powerful position. It is not difficult to see why 'calling for help' might mean something for Amanda; indeed that it might mean something to her at several different levels at once. Whilst I was surprised that Amanda rarely spoke to her peers in this 1990s New Zealand classroom, I came to understand why, in every lesson for which I have a transcript of her private talk, she frequently took up Mrs Southee's invitation for help. In this sense she initiated the interaction. These requests surprised me because my observations led me to believe that Amanda was party to this process merely through her exemplary behaviour. I have selected the following passages, to examine what takes place:

Amanda:      Mrs Southee? Is this exactly the same with a third instead of a half?
             {29 July}

Amanda:      Where's Mrs Southee? Where's she gone?
             I'll ask her when she comes back.
             {28 July}

Amanda:      Mrs Southee? How do you know the distance from the aeroplane?

{22 July, 2.06pm}

Amanda:        Mrs Southee? What's 'c'? Do you just have to work out...
               {22 July, 2.03pm}

Amanda:[*to Mrs Southee*] Do they look right there?
               {12 August, 9.13am}

Amanda:        I'm confused! I'll ask Mrs Southee.
               Mrs Southee?
               {12 August, 9.42am}

Amanda:        Mrs Southee? Can you help me with number twelve?
               {13 August, 10.55am}

Amanda:        Mrs Southee? I'm not sure about drawing the line on them.
               {13 August, 11.07am}

Amanda has worked out an answer to be $x^{7/3}$. She compares this with the answer given in the book as $\sqrt[3]{x^7}$.

Amanda:        Mrs Southee? Why do they change that one to the square root?
Mrs Southee:   No, it wouldn't be. It would be the CUBE root of x to the seven. Because it's given in that form.
Amanda:        So you have to give it back in that form? So that's the same thing.
               {7 August}

In an earlier lesson Amanda has revealed subtle misunderstandings with exponents:
Amanda:        Mrs Southee? Why, for number two, all of the answers you've changed that, and put the x to the power whatever?
Mrs Southee:   Well, that's negative on top and it becomes positive on the bottom...
Amanda:        But why is that one, you've written it as five x?
Mrs Southee:   Well, it's already positive.
Amanda:        So if it's negative up there...
Mrs Southee:   It is convention to write things with positive exponents.
               {30 July}

Mrs Southee uses Amanda's confusion as indicative of problems that all her students might be experiencing. Immediately after speaking with Amanda she returns to the board to speak to the whole class. This sequential practice of helping Amanda, followed by

whole-class clarification, happens frequently. The 'model student' is instrumental in foregrounding mathematical problems common to all students.

Mrs Southee:*[to class]* X to the power negative two is one over x squared. Are you all happy about this? If you have one over 'a' to the power negative three, it's the same as 'a' cubed. If you have one over 'm' to the power four, it's going to be 'm' to the power negative four. Now it's convention, listening, it's convention to write things with positive exponents...
{30 July}

The knowledge/power relations are clear. Amanda constructs for Mrs Southee a version of the student, and a version of the teaching/learning process, just as her subjectivity constructs a pedagogical position for Mrs Southee. In that Amanda's mathematically divergent propositions are not discounted but are instead used as a benchmark to reproduce and naturalise other more conventionalised forms of mathematical logic, Amanda contributes to the normalising processes of what is to count as mathematical knowledge within the classroom. Thus mathematical knowledge is inseparable from the politics of the classroom. This is not to suggest that school mathematics is *reduced* to that politics, but it is to make clear its fusion with the network of political and social practices. To the extent that this works against the official construction of the female student as set out in "Mathematics in the New Zealand Curriculum", it does not make sense here to speak of Amanda as the passive, oppressed, universal girl in mathematics, hermeneutically internalising mathematical 'truths' presented to her from outside of her.

**Femininity**

What seems clear here is that it would be useful to approach the question of Amanda's gendered subjectivity by exploring in more detail the idea of femininity discussed above. Such a framework is productive not only for this analysis, but might also prove insightful for investigating the way in which gender is fabricated and authenticated in other studies. When I looked closely at the story of Amanda's femininity what I uncovered led to a more complex attempt than what the literature on girls and mathematics portrays. I want to begin by making a few general points about the literature and the embeddedness of its sex/gender assumptions in what Nicholson (1994) calls biological foundationalism.

The earliest feminist position in mathematics education depicted the male/female distinction as caused by and expressed as facts of biology. Biological determinists used the work 'sex' to convey this meaning. Later, in the extensive engagement of feminists in

this field the word 'gender' was introduced, independently of 'sex' to allow for some elements in the social construction of femininity. But in this view femininity is not conceived of as totally socially constructed because social characteristics are superimposed on a 'given' physiological self. The term 'coatrack' (Nicholson, 1994) serves as a metaphor for the way in which differing cultural artefacts and different norms of personality and behaviour are placed upon the body. This coatrack view sees 'sex' as playing a crucial role since it grounds human identity by providing the location for establishing where specific social influences are to go. The difficulty with this approach is that gender is theorised as an additive, or a singly determined or causal factor.

In feminist poststructuralism, social variations in the male/female distinction are not merely related to what we know as feminine personality and behaviour but also to culturally various understandings of the body and to what it means to be a woman or a man. 'Gender' is defined and located within a set of asymmetric power relations between men and women as well as among women at a given historic juncture. What is crucial here is that the body becomes a *variable* rather than a constant, no longer able to ground historical claims about the male/female distinction. Since the girl is theorised in multiple and often contradictory positionings, created through material and discursive practices, there cannot be a universal category for her and hence we cannot say that she conveys or expresses 'feminine' attributes. But that is not to suggest that the physiological girl does not have particular effects and that 'femininity' is not an important social descriptor for how the male/female distinction is played out in identity politics within Western society. Indeed it would not be possible to draw attention to cultural patterns that privilege one group over another without naming categories.

Yet even as the girl and her femininity are politically useful terms they are also highly problematic. Feminist poststructuralists (for example, Davies, 1998) warn us of potential essentialising that can take place in heightening the girl's visibility. Strong category membership claims that tend to naturalise femininity, fall back on arguments of biological foundationalism which overlook important differences within the category of girl. It is more useful to speak of the girl as *inscribed* in femininity. In that theorisation a model of universal femininity drawn from biological determinism or foundationalism becomes contentious.

In the classroom, the self that Amanda presents to others is seen as normal and acceptable, and as competent in the gendered practices and ways of knowing and of being as constructed within the terms of her culture. I want to read her femininity as a performance (Walkerdine, 1989), staged within apparatuses of regulation within the classroom (and in the home) which take so much force that it reveals itself to Amanda

and to others as an apparent technique of self-production. To understand this requires that we think of the knowledge that Amanda has of herself, and which she expresses to others, as a female mathematical learner, as inseparable from the way in which 'girl' signifies within the social order in which she finds herself. Gender then cannot be an established social identity but a dynamic practice shaped by ongoing interactions. To this extent, the transcripts exposed the strategies through which power relationships were variously designated and continually changing between her teacher and herself; relationships in which certain actions of one modified the actions and behaviour of the other. What is extremely important in this is an understanding of power as relational. Amanda's self-knowledge is formed through a *complex relational process* through which power is exercised and in which both Mrs Southee and Amanda play a critical part. In Foucault's theorising, it is a relation incited by and intimately aligned with resistance and freedom.

Gendered subjectivity then cannot be fully understood within the terms of compliance to a naturalised form of 'girl' as signified and produced in this classroom. To be sure, the classroom has already been structured by specific power relations and material conditions which have set limits upon the modes of interaction that Amanda can express in her expression of mathematics. These social relations and meanings, as we have seen, are based upon the tacit and explicit knowledge of girls and femininity produced in the classroom by Mrs Southee. I want to suggest that gendered subjectivity 'works' most effectively for the established hierarchy of power relations in the classroom when the position which Amanda assumes within that gendered discourse, is taken up, or consumed, by her, precisely because of the strength of that discourse and because of her own interests and investments in that discourse. But I want to argue for more than this: that Amanda's gendered work is a practice of inventive, resourceful and strategic moves in which power plays a crucial part.

## Aesthetics of Existence

Insofar as we conceive of power in Foucault's terms as operating not upon its objects but within them, not from above, but from below, not outside other relationships but across them, then power must be creative rather than repressive. It is in the creative space that constructions and reconstructions of the self become possible. Since the self is not a 'given', then Foucault asks that we think of the possibility of "creating ourselves as a work of art" (Foucault, 1984a, pp350-1). In this section I want to provide a reading of Amanda's practice which takes up Foucault's idea of an aesthetic reinvention of the self. McNay (1992) cautions that the idea of an aesthetics of the self has been a source of considerable difficulties for many of Foucault's commentators. My intention here is not

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to pursue those disputes but to suggest that the central problem of the theory of the self can be circumvented by moving Foucault's priority of an isolated individuality onto a demonstration of how the self is constructed through various process of social interaction, leading to individual and collective change. It is through this means that we can focus on the government of the self, by the self, in connection with its relations to others. For Amanda's work in the mathematics classroom, this relationship is described in pedagogy.

A demonstration of how the self is constructed privileges a notion of the self, establishing a relation with the self, but it does not allow for an understanding of the self as embedded in and formed through various forms of social interaction. It is important to remember that Amanda is a nexus of relations formed in response to ever-shifting problems. Precisely because she has no essence, her subjectivity can be altered or abolished by new practices through others, inserting their actions into the contingency of historical events and institutions. By thinking of freedom in this way, we can now say that Amanda is never totally determined by the narratives and discourses in which she is inscribed. But at the same time, neither is she totally free to transform her life in the classroom. Agency as it plays out in the idea of an aesthetics of existence, of turning her classroom practice into a work of art and shaping that lifeworld according to stylistic criteria, is an ongoing process of self-critique. It is a process which sees Amanda questioning her limits within the discourse in which she is positioned, and problematising her own, and others', thoughts, talk and actions. This questioning plays an analytic role by exposing the strategy of power being played out. This may lead to a new way of thinking and acting.

I want to consider the idea of an aesthetics of existence as folding into the notion of subjectivity by proposing that to the extent that Amanda appropriates subjectivity as a mode of self-knowledge, and thus as a mode of aesthetic classroom practice, subjectivity will define the parameters of her options, her powers and the normal and acceptable range of her behaviour. In short, it will circumscribe her classroom practice as a work of art. In producing herself in this way she is involved in an ongoing and complex interplay between the practice of freedom and 'reality'. The idea, then, of Amanda's aesthetics of existence refers to those creative projects by which she, through creating a space within the discourses she is positioned, sets herself rules of conduct, and by which she intentionally works at transcending both her classroom practice and herself. It is contestation over meanings and discourses which ultimately may produce new collective circumstances.

Clearly Amanda fits easily into the psychopedagogic discourse of passive 'other to rationality' in school mathematics. Those other discourses which have a large measure of her peers in the classroom have little relevancy for Amanda in this classroom. What is all-important is the pedagogical relation. There is no struggle over meanings between Amanda and her teacher about what it means to be a girl in school mathematics. In that respect the classroom becomes a safe place in which Amanda might speak and act. But it is speaking and acting within certain boundaries which are not set in place once and for all but receive constant reconfiguration.

Amanda understands herself in relation to this interpersonal and political context as scarcely contradictory. She recognises the fit between her own and Mrs Southee's discourse of the learner. But is not a perfect fit; indeed interdiscursivity is always fragmentary and unstable. Amanda questions her own limits within the discourse, aware of the irreconcilable tension between the search for an 'empowering' place from which to speak, and within which to act, and the price at which this secure place will need to be bought. She may not yet be able to articulate that price. She locates spaces where possibilities of advantage for herself in this classroom might arise. In relation to the forms of practices and social interaction which are validated within the classroom, she actively and 'freely' makes choices about how she will construct herself as a work of art. These choices are never fixed since they are always made in relation to new interests and ways of doing things, according to the criteria as set by Mrs Southee.

It is in this way that I would like to suggest that Amanda creates her mathematical work as an aesthetic exploration. She has, in the words of Davies (1997), come to see the multiple ways she is positioned and the ways in which she is constituted first through one discourse and then another. She takes up a knowledge of her own specificity, with a political awareness, recognising that she is always constituted and always constitutive of others.

## Conclusion

Initially I was confronted with Amanda's apparent silence. By extending what is taken for granted about the nice, quiet and good girl within the available psychoeducational discourse, I worked at issues which this conventional discourse fails to engage; towards a theory of the possible and towards the construction of new understandings of her formation. In an attempt to address the problems associated with constructing femininity as a universal category, I looked at how Amanda lived her classroom practice and how she operated in the limited terrain of self-production which was open to her. This required

that I make explicit and thus politicise aspects of her specificity and how they were prompted and sustained. These details pointed to her practices as signifying astute management because they are about how she advances and flourishes in the mathematics classroom.

Looking at Amanda's mathematical practice by this means has allowed me to historicise femininity and produce an account which locates its forms and functions as discourse, and as a set of lived contradictory practices. The struggle over gender meanings for Amanda masquerades as complicity but it is, in actuality, about her transformation of the conventional storylines of femininity. This pointed to the contradictions, hidden and distorted by everyday understandings of girls in school mathematics, and hinted at possibilities for social transformation and what might be possible for releasing the bonds of already existing discursively constructed spheres.

# CHAPTER NINE

## Lived Mathematical Experiences:
## Stories from Rachel

> This theme of struggle only really becomes operative if one establishes concretely - in each particular case - who is engaged in struggle, what the struggle is about, and how, where, by what means and according to what rationality it evolves. In other words, if one wants to take seriously the assertion that struggle is the core of relations of power, one must take into account the fact that the good old 'logic' of contradiction is no longer sufficient, far from it, for the unravelling of actual processes. (Foucualt, 1980, p164)

### Introduction

When I visited Highbank School in the middle of the school year to present my research plans to Mrs Southee's class Rachel was one of the few students who expressed an immediate, enthusiastic interest in participating. This interest she communicated both to me and to her friend, so it was not a surprise when I received her own and her parents' consent form to participate in the research. Earlier when I had discussed the class composition and possible volunteers with Mrs Southee, Rachel had been recommended as of "likely considerable interest" to my research.

Rachel presents as lively and fun-loving. Of medium build, she is shorter than average height. In her words: "I got picked on a lot because I was short. I still do. It's just a constant battle over that, but it gets a bit old, though." She has long blonde hair, usually tied into a ponytail, has a pretty face and an infectious laugh. "Giggly", is how Mrs Southee put it. Every mathematics lesson, she sat herself at the same desk in the middle bank of paired seating arrangements at the front of the classroom, alongside her friend Kate. Amongst the girls within Mrs Southee's class she was branded by her school uniform. Rachel and her friend Kate were the only two girls in this class of mostly fourth year students who were not eligible to wear 'mufti' because this was only their third year of secondary school. How Rachel came to be promoted and what happened during her third year of school mathematics are part of her story. Her contradictory and conflictual experiences tell another.

I deliberately chose an 'extension' student as my case in order to question the assumptions made about girls in mathematics within mainstream mathematics education. I want to suggest that such research, while it claims to tell the truth about girls, in fact regulates them and overlooks other important aspects of subjectification which cannot be contained within that discourse. The account that I have produced of Rachel's

experiences is more a rendering of disruptions and tensions, than a series of static controlled moments. In narrating her story I have tried to capture the competing discourses that work through her words. This meant that I needed to look beyond the literal reading of what she said in order to tease out those opposing categories within which she structured her dialogue. My efforts then centred on how she took up the various discourses which were made to signify to and position her.

## Stories from home and early school

Rachel is her parents only daughter. Her father works as a computer technician and her mother is employed as an accountant's clerk. Her brother is two years older than she is and is in his final year of schooling at the same school. His mathematical achievement has been recognised by the school, enabling him to enrol for the two academic mathematics courses offered at seventh form level. Each school day on their way to work, Rachel's parents drive her to her friend's place from where the two girls walk to school. After school she has a regular job delivering newspapers to local households. Although she considers herself well cared for, and 'happy', Rachel has misgivings about her place within the family:

> I hate being the youngest because they don't trust me. Because I'm totally different to what my brother was so they can't handle it if I go out or something like that. And I find school easier than my brother did.

> There's always little things that annoy my parents because I'm so different to my brother. They could cope with it with him but they want me to be the same because they know what to do if I behave that way, but I don't. But it's a constant thing to try and do well so they'll be happy with what I do because I can go home and, because I find things easier than my brother, I could go home and say that I'd got 90 per cent on a test and my brother could go home and say that he got 60 but they'll be more happy with him, because they just assume that's what I'll get anyway. So it doesn't matter, it doesn't matter how hard I work for it.

> It doesn't feel like [I can please them]. Probably can, but it doesn't feel like it.
> {interview}

In communicating her story to me Rachel constructs herself as the unitary humanist individual, articulating the present as concrete and stable, to make her telling intelligible

both to herself and to me. In describing her feelings, she narrates her events in their immediacy, as parental failure to recognise her efforts, and her own place in that failure. Locating fixed and unyielding characteristics within herself, she casts herself as untrustworthy, unable to be handled, as an annoyance, as different and in opposition to her brother. As the younger child in a responsible nuclear family, she relates her story of struggle for justice and fairness from significant others in her life. Suggesting that these others present a powerful and unrelenting front within which she is caught, she is reduced instead to what she recognises as 'feelings'. This sense of not being able to do well enough, despite evidence to the contrary, has reverberated throughout her school years, marginalising her commendable academic efforts.

Reading Rachel's account from within the discursive frame of girls in school mathematics requires that we understand the family as a site for the production and the regulation of the modern conception of the individual. This is not to suggest that this particular reading is definitive and final, nor that other readings cannot be constitutive, but it is to argue at the very least that gender difference must be made relevant.

In chapters 1 and 6, I suggested how the modern conception of the individual became a necessary strategy for the modern techniques of mass regulation. The family as one of the modern apparatuses of social regulation creates, normalises and gazes over the individual child. But this monitoring is not readily apparent. Rather it is through covert means that the family regulates exemplary practice to ensure a stable, nurturant environment for the realisation of individual and collective social progress. Within the bounds of its statutory practice, the family's production of self-regulating individuals revolves around the issue of conflict. Within humanist theory the resolution of conflict between parents and children has been individualised as a mastery of frustration, reduced through the medium of language to the notion of 'feelings'. In this shift, conflict is regulated by a practice which fails to take into consideration any relational dynamics between the parties involved. It is in this sense that power and desire become unaccounted for.

Weedon (1987) argues that the ultimate concern for parents is the child's normality. Normality is socially defined and, as it relates to the family, determines what counts as acceptable child-rearing practice and behaviour. Through a variety of sources working through a range of discourses and social interests, parents in Western cultures learn and soon come to know as common sense how their children are to be designated as normal. These understandings are informed by notions of nature, appropriateness, and morality and are not unrelated to girls' and boys' future social destinations within society. We can draw on this notion of normality and tie it in with the concern for a resolution of differential performance between members within the same family to suggest why

Rachel's parents might play down her mathematical performance while elevating that of her brother.

The forms and relations of familial arrangements profoundly influence what can be said and what can be done by family members. Understanding the dynamics of Rachel's family relations is a book-length undertaking in itself and beyond the scope of this work. 'It doesn't feel like [I can please them]. Probably can, but it doesn't feel like it'. And later: '...she's *[Rachel's mother]* in such a shitty mood with me. She's still not talking to me hardly. And any time she wants to talk to me she complains about my homework' {25 July}. What she wanted to say was not within the scope of the humanist language available to her, and trapped by its powerful binary structuring links, Rachel was denied speaking something different into existence. We can read what Rachel says largely as a conflictual state and a tentative indicator of her own sense of powerlessness. Positioned as a female child and the youngest, she is located in the lowest hierarchical position within the family. On the one hand, the family's power appears prohibitive, restraining her desire to please them, holding her back with what Davies (1997) terms as feminine "inhibited intentionality" (p18). Sustaining her subordinate position in the male-female binary, however, is pitched, on the other hand, against the attainment of a powerful and ascendant embodiment. One regime of truth opposes the other in a struggle for dominance, shaping her desires. Yet there does exist a degree of manoeuvre and a possibility of resistance. This will occur when one or other regime renders her desire as momentarily correct and inevitable. Grosz (1990) puts it like this:

> The subject is named by being tagged or branded on its surface, creating a particular kind of 'depth-body' or interiority, a psychic layer the subject identifies as its (disembodied) core. Subjects thus produced are not simply the imposed results of alien, coercive forces; the body is internally lived, experienced and acted upon by the subject and the social collectivity. Messages coded into the body can be 'read' only within a social system of organisation and meaning. They mark the subject by, and as, a series of signs within the collectivity of other signs, signs which bear the marks of a particular social law and organisation, and through a particular constellation of desires and pleasures. (p65)

The family is able to offer Rachel ways of being and behaving and modes of psychic and emotional satisfaction or dissatisfaction. These modes of behaviour, however, are not steadfast in their specificity precisely because the family like all other social institutions, is a site of discursive battle over 'naturalised' childhood and constantly undergoing challenge. What I want to stress is that I am not claiming that Rachel's parents are designating a subject position for her which will provide her with the *only* sense she has of her identity in school mathematics, but rather suggesting the place of that designation in the naming of her as a subject. What I *am* claiming is that Rachel's subjectivity is produced at the intersection of a number of often competing discourses and practices,

each vying for her attention, and all of which position and designate her in some way. In this sense Rachel can never be fully reducible to any one regime of truth. Mindful of her conscious and unconscious past, she is, however, in an important sense newly constituted in each new set of relations and positionings within discourses in her everyday life.

This confrontation can come from outside the terrain of the family. The school is one site which can offer competing discourses and practices. Her decision as to whether or not take up these discursive tools does not tell us something fundamental about her nature. Nor does it tell us something fundamental about her mind. What it points to instead is the power of those practices and discourses. I want to look now at those practices operating within her schools.

Almost all New Zealand students who take the School Certificate external national examination in mathematics are Year 11 students. Rachel sat the examination one year earlier in Year 10.

> I remember my standard four [Year 6] class and I was doing extension maths and everything and, um, I know that there was one question in my standard four maths book and my teacher didn't know the answer to it. And I worked out the answer and it was different to the one in the book and I had to go round all the teachers to find out what it was.

> It was a big shock when I got to third form [Year 9] because suddenly you had to understand this stuff. But I didn't find it too hard or anything. It all goes back to the really basic stuff that you do in primary school and that.

> But doing School C [School Certificate] last year - that was a bit of a thing. 'Cos I missed two months of school, something like that last year 'cos I was off sick for six weeks and then for a month I was overseas and so I was cramming two years of stuff into less than a year. Such a rush! I learned most of that by teaching myself because I couldn't understand what Mr E was getting at. It was just going right over my head. It went right past me so I had to do it all by revision to get School C.
> I wanted to do School C because I was finding third form really easy and so I thought that fourth form would just follow on from

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that and be really easy and I would just get bored and give up. And I wouldn't want to do it when I came to fifth form [Year 11]. I wouldn't want to be working on it, because I'd be so sick of it and so I wanted to do something last year that sort of extended me a bit because fourth form tends to be a bit of a wasted year. It seemed to be at the time, but you look back now and it's not, 'cos all the stuff you did last year is really valuable. But, um, I just wanted something to aim for, for that year, otherwise I wouldn't have got anywhere.

Third form was just a standard third form maths. In the third form we had Mr S and he gave us a lot of extension stuff and moved quite a few of us on. Fourth form [Year 10] you were trying to push ahead.

I got 81% for School C, which I was really happy with it at the time, especially considering I taught most of it to myself.
{interview}

As I have pointed out many times, subjectivity is created in the practices in which people are made subjects, and are regulated. What I want to suggest is that if we look closely at the relation between the fictions of abstract reasoning in mathematics and the ways in which they are made to function in Rachel's desiring, then we might begin to understand her accomplishments in mathematics. I do not think that we can explore the constitution of this subjectivity without examining how the "mastery of reason" (Walkerdine, 1988) is made to signify.

In the context of the school, she places herself in the powerful ascendant half in the male/female binary. The contradictory subjectivity which this lays open argues for the idea that gendering in the course of daily life of the student is a process, operating with an effectivity that varies from one moment and place to the next.

Rachel's desire to aim high towards a difficult goal, and subsequent subversion of institutionalised gender positions within mathematics is not formed from any perception of teacher as role model. Nor, indeed, has it anything to do with an accessibility to mathematics enabled by the teacher, although she does concede that her Year 9 teacher 'moved quite a few of us on'. In Year 10 she was forced to reconcile the dilemmas encountered from missing regular classes for what amounted to about eight weeks, and the dilemmas engendered from what she saw as an unfruitful pedagogical relationship for

her positioned as learner. 'I couldn't understand what Mr E was getting at. It was just going right over my head. It went right past me...'. The problem was resolved by Rachel taking control of her own learning: 'I learned most of that by teaching myself'. The classroom miseducative experience took on an critically educative meaning with self-satisfying rewards: 'I was really happy with it at the time, especially considering I taught most of it to myself'.

Rachel depended on her earlier mathematical success to inform her of what practices she was required to perform in order to succeed in School Certificate. She gives us her own justification of her desire to succeed as being a relief from getting 'bored'. 'I wanted to do something last year that sort of extended me a bit because fourth form tends to be a bit of a wasted year'. Overlaying this justificatory strategy is another more powerful discourse through which she reveals her fundamental motivation. Her mathematical efforts, in which she, consciously or not, ultimately usurps the gender order, rests on the *a priori* modernist understanding of rationalism, and thereby, mathematics, as crucial to the survival and progressive development of individual and collective democratic social life. 'Otherwise I wouldn't have got anywhere'.

In my analysis, Rachel's primary motivation was humanist: to progress; to come out well-equipped and career-advantaged at the end of her schooling; to move forward. Woven into this desire is another discursive strategy, one which is reactive to the regime of parental disenchantment: 'it's a constant thing to try and do well so they'll be happy with what I do'. The personal investment here lies both in pleasing her parents and in the possibility of enjoying the accreditation which Rachel feels is her due. Taken together, these discourses point to, at least at Rachel's level of awareness, the striving for School Certificate as both desirable and inevitable.

What is of major interest for me is the part that mathematics itself plays in the discursive pull of Rachel's desires. In chapter 2 I referred to mathematics as enjoying high status within the social realm, a status which is derived from its apparent value in international competition, capital accumulation and market and product development. I discussed how what we have come to know as abstract reasoning was itself produced within highly specific practices. I want to pursue that argument in more depth here to try to understand why mathematics, the kind that is more to do with abstraction than concretising, might be so important to Rachel. Davies (1994) has argued that:

> In our education systems we tend to valorise abstraction as a higher, purer form of knowing, to treat it as if it is separate from the concrete while at the same time being a tool with which to analyse and describe the concrete. Or sometimes we see the concrete merely as a path to the more valued abstraction. ( p5)

What counts as 'abstraction' is a form in which all external reference has been removed. This has been such a successful discursive strategy that most people "experience mathematics as pure and uncontaminated by the real world" (Apple, 1995, p333). Successful though it may be it is nonetheless neither natural nor inevitable, but deeply "caught up in the major fictions and fantasies which are inscribed in the Logos and Ratio which are central to the maintenance of western patriarchal government and culture" (Walkerdine, 1993, p459). What we have come to know as universal abstract thinking is nothing less than a production in fantasy, something that Rotman (1980) has termed "Reason's Dream", one that is intimately connected to the workings of power and regulation in our current social order. It is a "dream" that, in its fictional specificity, operates outside the parameters of time and space.

In western societies this reasoning, which is synonymous with mathematics, is produced out of a *forgetting* of the very finite and expendable nature of the world, and the place of reason in the regulation of populations (Walkerdine, 1993, p466). To most people "mathematics [i]s a cold, formal, logical, mechanical, monolithic process of sheer intellection" (de Millo et al., 1986, p269). Ernest (1995) makes a similar claim. He argues that the popular face of mathematics as abstract, ultra-rational, logical, deductive, difficult and cold is sustained by the privileging of rational and scientific knowledge in our social practices as pure and true. An understanding of how this power operates in Foucault's terms requires that we imagine it as a dynamic of non-centralised forces. Its operation is not random nor haphazard, but configures to assume the forms that have historically been constructed for it. In mathematics these forms relate to historical claims for a science of the rational as the only method by which to realise modernity's promise.

Restivo (1991) takes up the notion of 'purity'. He maintains that within the discipline itself, as specialisation proceeds, the concept of mathematics as pure mental activity becomes increasingly prominent and plausible. Employing purism as a means of extricating all that is undesirable from the discipline, mathematics, in its consistency, its completeness, its detachment from all political affiliations, its timelessness (Bishop, 1988) and its total 'objectivity', is aligned next to godliness. "Purism is an intellectual strategy that has multiple roots and functions" (Restivo, 1992, p156), none the least of which is to generate status and prestige both for mathematics and the community in which it is practised. Purism works in highly ambiguous ways, installing a myth of precision and profundity; producing a suspension of disbelief (Willis, 1990). To this end, Walkerdine (1989) has noted that the meaning of the term 'statistically significant' is often taken up as 'importance', in that arguments presented mathematically or statistically

are likely to be accepted uncritically. And as Willis (1990) has argued, invoking numbers, statistics and formulae can be more persuasive than well-known authorities.

Given that the capacity to think abstractly is critical for democratic citizenry, advanced and abstract reasoning yields certain cultural capital (Davies, 1994). The human, civilised, abstract reasoner is a crucial resource for the powerful elites in any society. Restivo (1993) argues that in the control of systems of knowledge the reasoner plays a significant part and because of this is recognised by all as deservedly successful and is hereby empowered. This played out in a study undertaken by Johnston (1994) of Year 11 girls in Australian High Schools. Investigating how, why and what non-compulsory mathematics girls chose, Johnston found that the vast majority interviewed enrolled out of an understanding of the importance of mathematics, even when their interests were not in the discipline. Based on their past classroom experiences, arguments put to the girls of the intrinsic worth and practical use of mathematics held less sway than the necessity of mathematics as prerequisite to further education at the tertiary level and future employment. As one girl put it: "you do maths just to prove you have a brain" (Johnston, 1994, p241).

Willis (1990) writes of school mathematics as a "critical filter" (p207). Zevenbergen (1994) pursues the issue:

> Mathematics becomes a social filter to sort out those who gain access to the high status, wealth and power associated with certain professions and those who can not...The credentialing process of schools ensures that those students who are able to be successful in mathematics come to perceive their success as natural. In this way, the power, status and wealth associated with high-profile professions is legitimated for those who acquire it and for those who have been excluded from it. (p1-2)

It is this very power which mathematics engenders that works on Rachel, regulating elements of her desire and embodiment (Foucault, 1980). These forms of power render mathematics as neither authoritarian nor conspiratorial, but rather situate it within its meritocratic prestige as an intellectual discipline (Willis, 1990). Yet they produce and normalise social groups to serve prevailing relations of dominance and subordination (Bordo, 1993). Willis (1990) elaborates the point to argue that "the reality of school mathematics is that it is used...for intimidation, socialization and selection" (p192).

Zevenbergen (1994) argues: "it is no coincidence that those who are excluded from the study of mathematics are those social groups already marginalised in society - women, the working class and non-anglo-Saxon" (p1-2). Johnston's study cited above, provides us with a glimpse of the way in which the power of mathematics works "as a stereotypically masculine domain, and as antithetical to the cultural stereotypes of

femininity" (Ernest, 1995, p455). Having chosen mathematics, the girls in Johnston's study were counselled by teachers into specific mathematics courses, the appropriateness of which was based on the girls' past achievements. Girls were not actively encouraged or persuaded to pursue a higher level course, despite past evidence of ability. Johnston concluded that girls are receiving mixed messages: on the one hand that mathematics is crucially important for their futures, and on the other hand, that their ability to study the form of mathematics necessary for opening future options, may be in doubt.

It is precisely these dilemmas which faced Rachel: the power of the mathematics as a critical filter to future opportunities, against holding intact the male/female binary as this division works through mathematics. She sees and organises her subjectivity in relation to these discourses. Both discourses provide unique preferred way of doing things, and covertly stipulate what counts as right and normal. They both propose ways of thinking and behaving for girls but what one offers is contradictory to and in competition with the other. If Rachel attempts to put into practice implicit prescriptions set out by the discourse of mathematics as masculine she will be led to reproducing the relations of domination in the male/female binary. The way gender is discursively constituted makes power problematic for her as female and the taking up of alternative tools and knowing herself outside the gender order might be read as a transgressive move. However, positioned as she is in this site of disunity and conflict (Weedon, 1987), Rachel will be exposed to opportunities for 'doing gender' differently, precisely because, as Butler (1990) says, what is sometimes named as 'agency', or 'freedom', or 'possibility' to subvert the status quo is produced by gaps laid open by the regulatory norms in the process of their self-repetition. To the extent that she disengaged herself from those normalised gender patterns, she moved into a position central to political change.

## The Pervasiveness of Power within the Classroom

In this section I want to look at the discourses and practices that are used to organise Mrs Southee's classroom. In this way it will be possible to see how power is wielded in the 'reality' of Rachel's classroom life. It will enable us to see how discourses make real to her the social structure, the relations of power, and the differential positioning, histories and the desires of others. In the next passages I attempt to prise open Rachel's classroom 'experience' which, in humanist terms, would figure as fixed, immutable and natural. I want to ask instead what this experience excludes, how it got to be there, and on what sort of foundational basis. This effort then sees Rachel, the speaker, as a *temporary fixing of identity* within the structures of the discursive situation in which she is located. Recasting Rachel's experience in the language of poststructuralism and discourse, and drawing on Butler's (1990) notion that change can be pursued and perceived at the heart

of power through the process of re-signification, it becomes possible to see how new mathematical meanings are made. These appear in the possibilities that arise from an understanding of meanings as never fixed nor stable.

On entering her third year of secondary schooling there was never a moment of doubt in Rachel's mind that she would enrol for the Year 12 academic mathematics course offering at her school. There was no hesitation by the mathematics department either since Rachel's School Certificate result of 81% had accredited her with an A grade. She along with three other third year students would be assigned a place in Mrs Southee's class. At this level, introduction into the world of mathematical discourse of calculus occurs as part of formal classroom talk. In the following passage the class has been using the process of differentiation to find the gradient of a curve, making use of the conventional notation used in this procedure. Rachel and Kate are working on finding the gradient of the curve $f(x) = 3x^2 - 2x$, at the point $(1, 1)$. Richard and Blair sit behind them, a seating arrangement routinely chosen by all four. Amongst the 29 students in Mrs Southee's class, these four are the only third year students.

| | |
|---|---|
| Mrs S: | Two little steps: differentiation and then substitution. Make sure it's set out properly, not just a whole jumble of numbers with an answer at the end. Clearly distinguish between your original function and your derived function. Make this DASH very clear... |
| Rachel: | Three x squared. So, it's 6x minus two. Is that one? [refers to value of x] |
| Kate: | I don't get the dash. |
| Rachel: | Get the dash? Put in the one. Yea, cos, it's a bit like a 'one'. Now what do I do now? |
| | You put it as x here, aye? |
| | So you've got six minus two equals four. |
| Mrs S [to class]: | Check with the answers each time you do an exercise. You know maths is a practice subject. You must practise things correctly. |
| Kate: | [checking answers] WE WERE RIGHT! |
| Rachel: | YEA! |
| | [They begin working on the next problem which they read as : |
| | If f(x) = x⁵ - x² + 5x, find the gradient of the curve at the point (2, 13) ] |
| | So now you have f dashed x equals five x to the four, minus two x plus five. |
| Richard:[to Rachel] | That was quick. |
| Rachel: | I LOVE making him feel stupid. |
| Kate: | What's this one? |
| Rachel: | It's two, thirteen [cf, (2, 13)]. Dashed. Um. OH, TWO. |

| | |
|---|---|
| Kate: | So we'll put two at the... |
| Rachel: | Five times. What's...? |
| | Sixteen. OH? *[giggles]* What's five sixteens? |
| Kate: | Eighty. |
| Rachel: | Minus four. That's five. Eighty-one. UH? |
| Kate:*[to Richard]* | What's the answer to number five? |
| | *[Working it out]* Two. Sixteen. Sixteen times five... |
| Rachel: | ...is eighty, minus four, plus five. So minus this four. That's plus one. |
| | *[To Kate, demandingly]* Look it up. |
| Kate:*[to Richard and Blair seated behind]* | What's number five? |
| Richard: | Thirteen. |
| Rachel:*[to Kate]* | Have you looked at the question? |
| | So he's probably given it to us wrong. |
| Richard: | YOU'RE wrong, not us. |
| Kate: | *[mocking]* Oh, don't. |
| Rachel: *[to Richard]* | IDIOT |
| Richard: | YOU'RE the idiot |
| Kate: | What number is it? |
| Blair: | Who's the idiot? |
| Rachel: | SHUT UP, Blair! |
| | Number five, exercise fifteen. Not that THAT really helps. |
| | What's the question? |
| Kate: | We looked up the wrong... |
| | We didn't get the right... |
| | We didn't write it down properly. |
| Rachel: | *[in disgust]* OH! Is it CUBED? It's cubed not x fifth! |
| Kate: | Yea. |
| Rachel: | *[Problem is then read correctly as:* |
| | *If f(x) = x³ - 2x + 5, find the gradient of the curve at the point (2, 13)]* |
| | So two squared. That's four. |
| Kate: | Times five... |
| Rachel: | What? Times FIVE? YOU'RE NOT TIMESING ANYTHING BY FIVE! |
| Kate: | Yes you DO! |
| Rachel: | NO. You've got to change that. Remember? So, that's a three. |
| | Four times three is twelve. |
| Kate: | Twelve. Minus four which is... |
| Rachel: | Three. |
| Kate: | Eight. |

Rachel:        NO. Twelve plus one, which is thirteen. OK?
Kate:          *[laughs]*
               {4 August}

By the time Rachel reached Mrs Southee's sixth form mathematics class she had already learned powerful lessons from classroom discourses which provide cultural meaning systems about doing mathematics. In the weeks she has been in this class, she has learned what does and does not count as student performance and its classification in Mrs Southee's classroom. Through this she has learned the regulative devices and normative positions produced for her as a student in this classroom. Mrs Southee's view of mathematical work has been made clear: that students learn from applying standard calculus techniques to a variety of situations and problems. Students will discover the power and the beauty of these concepts if they 'practise things correctly'. She had learned that correct practising can be validated by 'check[ing] with the answers each time you do an exercise'. This practising need not be individual. Indeed, collaborative work is encouraged. Mrs Southee's view is closely aligned with what counts as good pedagogy as expressed through "Mathematics in the New Zealand Curriculum". Like other conscientious teachers, she considers it her task to mediate the information exchange between the official document and her students.

Luke, de Castell, and Luke (1989) note that the aims of curricular design or the intent of teachers may not equate to what is achieved in pedagogic events. In that respect mathematical knowledge cannot be seen as seen as exclusively located in the official text or even with Mrs Southee because the power relations of the classroom discourse reconstitute what counts as a reading and an interpretation of valid mathematical knowledge and competence. If we take on board lessons from poststructuralism that school knowledge is produced through classroom discourse, we can read this passage as constituting a micropolitical practice around which pedagogical relations are built and sustained.

In this particular lesson Mrs Southee is acting as an 'initiator' (Luke, 1995-6) of the framing and establishment of the gradient of a curve at a fixed point. She constructs these parameters through two mediums: mathematical notation and speech. Anticipating potential transgressive action she directs her student's gaze towards the textual strategies which she has assembled and now requires from her students: 'Clearly distinguish between your original function and your derived function. Make this DASH very clear...'. In this she makes explicit a political and social order in which teacher and students are to inhabit differential and hierarchical positionings. She foregrounds the norms (and reasons for them) of mathematical practice in her classroom.

Rachel complies with this set of textual relations which Mrs Southee has constituted for her, by modelling the correct 'reading' of mathematics as foregrounded, namely, identifying salient terms and assigning these with the appropriate notation. Power has inserted itself into her action and attitudes, her discourse and her learning processes (Foucault, 1980). This is in no way to deny that social relations other than the dyad Mrs Southee/Rachel are at play. Clearly the passage points to intersubjective peer relations of power operating, whose functions can be assessed. It is not very useful here to think of how Rachel's knowledge becomes 'internal' by drawing on humanist notions of the individual. It is more productive to think in Foucault's terms, as seeing Rachel as an enunciative and theoretical strategy in relation to many others. This lays open an understanding of her experiences as relational. The talk that proceeds from her cannot then reify her as the subject of her speaking.

What becomes apparent from this passage is that Rachel takes up quite readily the discourse of 'how one does mathematics' as constructed by Mrs Southee. She is able to reproduce and naturalise the definitive moves: 'Get the dash? Put in the one. Yea, cos, it's a bit like a 'one''. She is also able to discount other strategies which conflict with the textual logic established: 'FIVE? YOU'RE NOT TIMESING ANYTHING BY FIVE!' This taking up of the tools (Butler, 1990) provides her with access to a powerful position amongst her peers. Holding the ascendant position in her dialogue with Kate, she also appears to gain some standing in the dominant powerful position which her competence afforded her, when Richard comments on her quick solution.

Her response to Richard is reactive. For Rachel to buy into the common sense male/female binary system means both buying into particular ideological narratives of social structures, gender roles, and power relations of a particular mathematical reality. And whilst she is not necessarily, in her relations with Kate, as seen through this passage, the epitome of the "nice, kind and helpful" girl of Walkerdine's (1990) study, she nevertheless considers Kate a good friend. In fact Kate is, in Rachel's eyes, her 'best friend' [interview], and she organises her subjectivity in the classroom partly in relation to the discourse of friendship.

She cannot ignore the boys sitting behind her. The previous year she had shown how it was possible to usurp the storylines available to girls in mathematics, and now drawing on those previously established gendered self-other identifications, she responds to Richard: 'I LOVE making him feel stupid'. And to Blair: 'SHUT UP, Blair!' These identifications with others, taken together, provide her with discursive resources for maintaining differential power relations of compliance and control between the two boys

seated behind her, and with Kate. For Rachel, power is, in Foucault's (1980) terms, not necessarily repressive, but operates through technologies of the self.

Thus it is possible to note the complex interplay of relations between the objects and techniques of the discursive practice of a select mathematics as employed by Mrs Southee, the reading of this practice by Rachel, and the construction of it in relation to her small peer group. The production of successful mathematical knowledge has for her in the past signified the reappraisal of gender categories. She plays this out again in the following passages:

The class has been investigating the derivative of the curve $y=x^2$. We take up the lesson at a point towards the end of Mrs Southee's whole-class elaboration:

Mrs S:          So for any point on that curve we can calculate the gradient.
                What's the gradient of the tangent, of the gradient of the curve
                at the point where x is eight? It will be sixteen. What's the
                gradient of the tangent there? [refers to point (-5, 25)]  Negative
                ten.

Throughout the whole segment of this lesson Richard has been keeping up a constant patter directly behind Rachel and directed at her. She finally says:

Rachel:         Just wait till you get out of the classroom, mate! Really quick! *[giggles]*.
                {23 July}

Passive throughout Richard's contradictory dialogue, Rachel finally asserts some control by issuing a threat. But both this passivity, and the momentary domination, are at best shaky and partial. If we look at the place of her giggling in this passage, my analysis reads it as marking Rachel's struggle to define her place within two conflicting discourses: that of Mrs Southee's discourse of school mathematics, and Richard's competing counter-discourse. In the next sequence, there is no doubt about Rachel's position within relations of power.

Kate has just checked her answer to a problem:

Kate:           Wow! I'm RIGHT.
Rachel:         First time for everything!
Kate:           You're just jealous.
Rachel:         No.
Kate:           I'm going to do the whole thing.
Rachel:         *[laughs]* You're not intelligent enough!

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Kate:              SHUT UP! *[laughs]*
                   {29 July}


In the following passage, the two girls draw on the strength and power of numbers to redefine their activities in the discursive struggle for position. Rachel and Kate are about to start an exercise in using the polynomial rule for differentiation but both have left their question books at home. According to the normative practice as set out in this classroom, arriving at class without question books is a divergent proposition, one that receives constant monitoring and regulatory measures from Mrs Southee:


Kate:              We need the questions.
Rachel:            YES. We DO. How many books have they *[the boys behind them]*
                   got up there? Must be at least two.
Kate:              Richard. Hey, RICHARD. We need a ...
Rachel:            BOOK. Give us a BOOK.
Richard:           No, I need it.
Rachel:            Isn't he MEAN. *[said petulantly]*
Richard concedes and gives the girls his book.
Rachel:            OH. 'Cos he LOVES us. Even on the right page, I think.
                   {30 July}


It would not be difficult here to make a case that Rachel is exploiting gendered relations by introducing female expressiveness found in popular cultural forms of women and girls and as represented through television and film. However I feel that such an interpretation is over-simplistic. The allure of young women is a complex phenomenon, and beyond the scope of this work. Suffice it is to say here that the phenomenon is one which places the girls in ambivalence, at once innocent and highly powerful. The next passage records the two girls working together on finding the gradient at the point (-1, -1) on the curve $y=1/x^3$.


Rachel:            One over x cubed.
                   OK. We can do this. *[sounding confident]*
                   No, we can't but we can try.
                   Oh. Cripes! Such a bad day!
                   Hang on! Doesn't the 'one' become a zero still?
                   So it's zero. So that becomes zero . So it's just x.
Kate:              Cubed, isn't it?
Rachel:            It's a zero. Over it. 'Cos zero divided by ANYTHING is zero.
Kate:              I don't get that 'one'. You have to put that down, there...

| Rachel: | Yea. |
|---|---|
| Kate: | And you put it UP. You change it. |
| Rachel: | Which one becomes negative? |
| Kate: | The power. |
| Rachel: | Yea. X to the negative three. Equals one times negative three x squared. UH? |
| Kate: | Negative four. |
| Rachel: | Why? |
| Kate: | Because you're adding. You're taking away 'one'. When you take one away from negative three.. |
| Rachel: | Yea, yea. Ta. |
| | So f dashed...What's the thing at? What point? |
| | What? Negative one, negative one? *[(-1, -1)]*. |
| | One, negative three times negative one to negative four. |
| | I'm totally all over the place now! |
| | It's 'one', isn't it? |
| Kate: | You go... |
| Rachel: | One to the power negative four. UH? OH! |
| | Hang on, so that's just 'one' there. One, negative three, is 'one'. |
| | Yea. Negative three. Yea. |
| | {4 August} |

The girls have at this stage had opportunities to see what counts as standard technique to finding the gradient of a curve at a point. They work hard at performing the required practices in order to be normalised into the discourse. This activity is fraught with conflict and contradiction but is finally resolved for them both working through social relations as normalised and regulated by the discourse of "Mathematics in the New Zealand Curriculum", and as operating in this classroom. This entails an intersubjective negotiation of ideas. Through this process what becomes clear is a see-saw of superordinate/subordinate positions which the girls assume. That is to say, momentary switches in power relations take place. In Rachel's words:

> We check against each other. We do that a lot and we race
> against each other and see who can get it down quicker. It's not
> a conscious thing. I mean, we work through it faster. I mean if I
> wasn't checking against her [Kate's] answers I'd be checking
> against someone else's answers. Most likely. And if I don't get
> it I start asking questions.
> {interview}

The following passage records the two girls working together, employing the rules of antidifferentiation for the first time. Rachel is acting in the capacity of Walkerdine's (1989) "subteacher". We pick up at the point where the two girls are working on antidifferentiating $24x^2$ and $8x$.

| | |
|---|---|
| Rachel: | I think that would WORK. |
| Kate: | What? |
| Rachel: | That's what I've got. But it didn't say that in the answer. |
| Mrs S:*[close by]* | It should. If you differentiate this... |
| Rachel: | That's what I did! |
| Mrs S: | ...you get eight times three x squared, gives you 24 x squared. Four times two x gives you eight x to the one, plus c. That's it. |
| Rachel: | OK. Cool. *[Mrs Southee moves away]* 'Course it was right. What am I thinking? |
| Kate: | When you do 'plus c', do you do it twice? Do you do 'plus c' once or twice? |
| Rachel: | Once. X squared. I was looking at the wrong one in the answer. That's why I thought I was wrong and I was right. It all comes from being dizzy. *[working]* Yes, I GOT IT! I'm ACTUALLY going to finish a maths book soon. *[refers to her own exercise book]* Isn't that scary? |
| Richard: *[seated behind]* | I suppose you filled it up with drawings and letters and things. |
| Kate:*[to Rachel]* | You ARE going to hit them soon, aren't you? *[referring to males seated behind them]* |
| Rachel: | Mm. {5 August} |

To understand how meanings are made here for Rachel we need to consider the structure of social relations operating at this moment of time and represented through a variety of discourses. There are several conflicting discourses at work here. Engaging with their complexity enables us to see Rachel initially trying to work within the given official mathematical discourse of the classroom: "Course it was right'. Secondly, we see her trying to work within given notions of gendered behaviour: 'It all comes from being dizzy' and 'Isn't that scary?' Finally she contemplates breaking with that gendered discourse, tentatively, in her response to Kate's question: 'Mm'. In all this she is constantly repositioning herself with regard to what constrains and what empowers.

### It all Comes from Being Dizzy

In the passage above Rachel refers to herself as 'dizzy'. I want to explore the way the dizzy female presents for her a repudiation of a figure of immense transformative power; a power which carries with it the face of the definitely 'boring'. This is not the only time Rachel was to use the term:

> I'd sum up [my personality] as dizzy...At the beginning of the
> year I decided I didn't want to be as boring as I was last year. I
> didn't enjoy what I was doing. So that's probably when I started
> not working and stuff, actually.
> {interview}

Dizziness is equated with enjoyment; transformative power with boredom. A classificatory grid about what mathematical work is all about is articulated. Achieving well in School Certificate as a second year high school student may have been desirable then, but right at this moment, it takes second place to the attractions of a more enjoyable school life. Why this is so can only be formulated around the pull of the various discourses and practices with which, consciously or otherwise, Rachel comes into contact. In my analysis, Rachel's categories are tied to the gendering of school mathematics; to the construction of how mathematical work is enacted on a gendered basis. Thus she saw and ordered her subjectivity in relation to the discourses about what it means to be a gendered learner in mathematics. As Ernest (1995) has argued: "Women must choose to be feminine or choose to be successful at mathematics. If they opt for both, they have to live with the contradiction mathematics ≠ feminine" (p456).

Davies (1994) lists a set of binary metaphors traditionally associated with maleness and femaleness. Amongst the terms by which femaleness is understood in lived and imagined narratives are the notions of chaos, and emotions/feelings. Aligned in contrary position, the ideas and ideals western culture takes to signify maleness are noted as order, and reason, respectively. Though these are recognisable distinctions fundamental to the maintenance of binarisms, and although we might recognise ourselves in one or other half of the mutually exclusive division, Davies argues that "at the same time we can enumerate many examples of transgressions, movement outside the binary division" (p9). Rachel has shown this capacity. It is a discursive strategy which she employs during her interview with me in naming herself as 'dizzy'. She does this in order to redeem her femaleness in relation to what she imagined as gendered subjectivity

enculturated in my eyes, after transgressing the reason/emotion divide. As she saw it, a counter discourse of reason was not feminine enough in my eyes.

Before my classroom observations had begun Mrs Southee spoke to me briefly about Rachel, alerting me to some possible potential conflict during my time at the school. It seemed that not long before, Rachel's behaviour in class had gone against what Mrs Southee ruled as acceptable practice to the extent, as Mrs Southee put it: "I lost my cool. I think that in all my years of teaching I have never been so cross with a student". Later Rachel volunteered to me: "[We] don't have a very good relationship, because we've had a few arguments in the past" {interview}. She elaborates why this might be:

> My aunty works in the music block and she really likes Mrs
> Southee. But the guys - they know that I laugh really easily and
> they keep making me laugh in class, and she [Mrs Southee] just
> gets really frustrated with me because when I start laughing I
> can't stop and so she starts getting really angry at me. And
> apparently no-one has ever heard her raise her voice before she
> met me [*giggles*]. So it's a bit stressed there [*sounding upset*].
> {interview}

Juxtaposing this passage with the one directly above points to a play of conflicting discourses. On the one hand Rachel is clear that enjoyment is all-important; on the other hand, controlling excluded classroom behaviour is to be aimed at. It is my contention that this conflictual discursive practice plays out for her long after the research took place. I make this claim on the basis of reports received of her from Mrs Southee one year later. I will return to this point shortly.

What Rachel says may help us tease out why she was so forceful in her interactions with the boys seated behind her. After her 'falling out' with Mrs Southee, there was some reluctance on Rachel's part, some doubt about the legitimacy of her reactive responses to the boys' chatter. She could not, as least while Mrs Southee was the holder of surveillance power, be fully reactive in this way again. In her interview with me she says:

> I'm just trying very hard not to let the guys get to me now.
> Then I don't have to laugh. Blair - he just likes really to get me
> in trouble and he has done that for the last three years and he'll
> just keep on doing it and there's nothing I can do so I just try
> not to sit in front of him. And hope that he doesn't sit in the
> row behind me.
> {interview}

Rachel's gender is lived as her own experience, but is not an analysable experience on her part, since it is discursively produced. Her words may have described what she felt had happened before the research took place. However I have very little recorded activity on the boys' part which matches what she describes, even as in all the time I was researching in her classroom without fail Blair chose the desk immediately behind her. She was at the interview articulating a defence of her previous laughter in class. She was also revealing the need to explain to me that she was after all an innocent victim. In revealing her subordinate position in this power relation, she was simultaneously exercising another form of power: the power of advocacy. Davies (1997) suggests that the power of assuring others of the legitimacy of one's behaviour is "probably essential for those who want to transgress the boundaries of the dominant culture or to deconstruct old patterns and speak into existence new ones" (p12).

## I'm Scared of that Woman

Acting upon the discourse of regulatory behaviour as deemed appropriate by Mrs Southee, Rachel rules out 'dizzy' and 'uncontrollable laughter', monitoring this behaviour through a technology of herself by going out of her way to prevent its reoccurrence. This points to an avoidance of any potential conflict from the boys to her self-normalising actions. At the same time it pointed to strained pedagogical relations:

| Rachel: | I don't know how to do number three. |
| Kate: | Well, ask. Ask. |
| Rachel: | NO. 'Cos I'm SCARED of that woman. She confuses me more. |
| Kate: | Just ask her. |
| Rachel: | Last time I asked her a question, and OK, admittedly it was months ago, right? But I asked a question and I sort of understood half of it, and when she explained it to me, I understood less. I understood nothing by the time she finished. OK? |
| | {30 July} |

In this excerpt, Rachel rearticulates some interpersonal conflict. She is only too aware of being watched and monitored for any behaviour that sets itself against Mrs Southee's predetermined idea of what is normal classroom practice. I want to discuss what happened in one lesson, early on during my visits to the classroom. In this I want to pay close attention to the complex relations between the desires and hopes of Rachel and others caught up within the pedagogical relation. During this lesson Rachel made many references to the mathematics as developed by Mrs Southee at the whiteboard. Each of these references was despairing.

Rachel: [2.31] I don't get it. I don't GET it. What am I... What do I make it...?

       [2.36] It's stupid. Can't do THAT.

       [2.37] Can't do THAT.

       [2.39] *[to Kate]* Don't worry about it. It's stupid.

       [2.40] It's cold. Stupid place.

At this point the students are asked to work through the classroom exercises. For the next nine minutes she talks to Kate about her hurt finger, about her friend Lisa, and about Kelly who is in Japan at the time. Here is what I wrote in my field notes that day:

> Rachel has untied her hair (2.46) and spends quite a lot of time flicking it back and brushing it.

At 2.49 Mrs Southee says: Some of you are wasting time.
In response Rachel says to Kate:

> I know every dude that she's talking about.
>
> *[quietly to herself,* I don't just get any of it. I just...I don't even know what she's trying to get at...I don't even know what...I don't even get what I'm supposed to be working for.
>
> Half an hour to go.
>
> *[slightly sobbing]* What am I doing...?
>
> {23 July}

Rachel cannot make sense of the work. Yet, given that her lack of understanding is important to the analysis, it is, I want to argue, not shaped by the terms of a developmental perspective. Nor is it merely the result of some constructivist inability to search into the depths of her knowing. How then can we explore her lack of understanding without recourse to the standard developmental or constructivist accounts?

When I listened to Rachel's tape at the end of this day I recall being profoundly surprised because her private talk into the recorder did not match my classroom observations of her and the notes which I made. What I 'saw' from observing, was that Rachel was concentrating intently during Mrs Southee's talk, that she later showed obvious signs of being distracted when she should have been working on the exercises, and then, after Mrs Southee's generalised surveillance remarks, became focused on her work. What disturbed me was what Rachel was saying. How can we approach this without pathologising her?

If we consider the issues here, it is clear that Rachel expects to achieve. That was all quite apparent from what we have already seen. Right from her early mathematical experiences she showed that she could turn the tables on what is commonly understood about girls in mathematics. Not understanding mathematics simply does not connect with her way of being in the world. The point I have been trying to make throughout in this chapter is that Rachel's understandings (or lack thereof) are produced in part in the complex history of the classroom in which she is already inscribed, by which her very actions, needs and desires are made to signify. What I see as central to my analysis, is the mathematics classroom itself. Yet this centrality is not at the level of classroom dynamics and pedagogical practice per se, but as a site in which certain meanings, and not others, can be made. My interest is not in any ability discussion, nor in the constructivist debate, but rather in understanding how Rachel produces a narrative of her successes, her difficulties, her hopes, and her frustrations in mathematical work.

That understanding requires that we look at the conscious and unconscious processes and meanings as they interweave through her lifeworld. It would be easy to suggest that Rachel's mathematical problems could have been solved if she had asked Mrs Southee for help. In that sense, then, understanding is deemed linear, and if misunderstanding arises, it can be quickly redirected into shape. Here responsibility rests with both parties in the pedagogical relation. However the work of Foucault has warned me that such interpretations are too simplistic. Understanding in mathematics is a complex phenomenon, in which gender and history play a major part. So too do issues of power, regulation and surveillance. To this end I am suggesting that Rachel's private talk here be taken together with her previous conflict with Mrs Southee, her reasons for this conflict (in which the boys seated behind her are implicated), her avoidance of dialogue and future conflict with Mrs Southee.

To understand this, I want to suggest that this complexity might be conceived of in terms of a psychic/social relation, produced not in ahistorical and universal categories, but in historically specific regimes of meaning and truth. This is not about Rachel's inability, nor about her 'otherness' in school mathematics, but about a complex construction of gendered subjectivity. Listening to the tape again, later, I found myself getting upset at Rachel's inability to understand the work, given her previous level of achievement and the apparent ease with which she picks up mathematical ideas. In Foucault's terms, the 'cognitive problem' that seems so acute here might best be understood as a contextual issue, not in Carraher's (1988) or Lave's (1988) sense of the word, but rather in the sense that Rachel is contextualised by being inserted into the practices of this classroom. In this understanding important issues of regulation and surveillance are involved and the issue may not have anything to do with cognition whatsoever.

There is no narrative in the developmental and constructivist accounts that addresses the oppression felt by Rachel, nor of the conflict between her and her teacher, and the contradictions that exist between her and the boys who sit behind her. There is no model in those perspectives that adequately accounts for her anguish in sliding in this lesson from self-recognised competence, which she has been eager to convey to me in interview, to a failure to understand, which she articulates through the tape recorder, yet goes out of her way to make inaudible to others. In her soliloquy, Rachel provides a counter argument to the one she has known herself by in her previous mathematical work. This is the first occurrence of this contrary position she is taking, one which is, from time to time, both explicitly and implicitly expressed in later classroom lessons. In this sense the classroom power relations shape the narrative through which she might express herself as a girl in mathematics and provides the discourse through which she might be judged.

As Rachel sees it, the only recourse open to her is quiet resistance. The class has been completing a table of ordered pairs for the evaluation of the instantaneous rate of change at a point. Mrs Southee has worked out the value of the instantaneous rate of change for y = $x^3$ at the point (2, 8) as 8. After a few moments she corrects her answer.

Mrs S:      Oh, this is what you get when you...It's actually eight. No, no. This one here should be twelve.
            That's right, isn't it?
Rachel:     How I love it when she's WRONG!
            {25 July}

When I asked her to talk about her position in the class, she diffused the situation, focusing instead on the importance of copying notes off the board and her friendship with Kate.

> Most of the time I get all the important notes and everything she writes up and a few of the examples. What I can get down before she rubs it off. *[giggles]*

> It would be lonely if Kate wasn't there. I don't know. I'd probably do more work, most likely. But I'm definitely looking at university.
> {interview}

## Conclusion

Through an encounter of Foucault's version of poststructuralism I have tried to come to terms with biography and previous education, with the pursuit of meanings, with theory and authoritative discourses. This theoretical orientation pushed me to reevaluate and refashion the comfortable premise of Rachel's gendered identity as stable and fixed. It required me to foreground the conditions and relations of production within which her mathematical work was generated. I looked at the discourses and theoretical tensions that affected Rachel's lived experience. In this I attempted to see how power and knowledge relations are structured in the classroom by looking at how Rachel lived them and how these relations of power informed and politicised her mathematical work. These were not able to provide certain once-and-for-all answers to questions about the conflict between what society demands of gendered meanings and the personal often repressed visions of what learners ought to be.

I have attempted to write of Rachel in relation to a number of significant others: her family, her teacher, her best friend Kate, and Richard and Blair who sit behind her. In linking all these together I examined how the production of her mathematical knowledge is tied in complex ways to particular historical trajectories and socio-cultural contexts. Just as it is place-specific, it is also a function of time. I make this point with regard to a later event. A year following the research I met Mrs Southee and asked how 'my' girls were getting along to which she replied in general terms that all were fine. In a more particularised note she asked if I had I heard that Rachel had left school, not having completed her seventh form year, to work, she thought, in a trading bank. "Such a waste of a good brain", she added.

To view the issue as simply one of "waste of a good brain" does not allow for the contradictory realities that Rachel confronted. That judgment can neither reveal the turmoil of learning nor acknowledge the deeply personal dissonance engendered by the circumstances surrounding that learning. The easy dismissal of Rachel's leaving and the assertion of ability cannot explain what it is that structures her practices and subjectivity and why she might have chosen to leave. Setting Rachel up in this way as if she escaped from a neutral zone within the classroom points to a discursive practice of her own blame.

As I see it, Rachel is caught up in discourses through which she was not able to exercise agency. She did not have the theoretical resources to look at the discourses in which she was trapped, to see how they each both constrain and enable things to be done and said. She was not able to see where power lay in each discourse and by which means she

could determine which practice could be refused and which could sustained. If she had been able to do so, she might have reworked those discourses towards personal enablement. In Davies' (1994) words: "In removing the site of the problem from herself to those structures...it is possible to see both the power of the structures and the inevitability of bowing to their pressure and to contemplate the ways in which those structures might be worked on to change them such that they do not in the future exert such intolerable pressures" (p24).

# CHAPTER TEN:

# Endings marking new beginnings

> This work done at the limits of ourselves must, on the one hand, open up a realm of historical inquiry and, on the other, put itself to the test of reality, of contemporary reality, both to grasp the points where change is possible and desirable, and to determine the precise form this change should take. (Foucault, 1984a, p46)

## Introduction

This thesis began with the question of gendered subjectivity of girls in mathematics schooling. I now return to that question. My response has been in the form of a theoretical and empirical inquiry; a version of the ongoing story of girls in school mathematics. This effort could only be accomplished through working through a dilemma: analytical work such as this cannot be founded on a theory of the girl in school mathematics since theorising assumes a prior objectification. At the same time, however, this piece of work could not begin to proceed without some conceptualisation of the schoolgirl in mathematics. Heeding this problem required that I pay attention to the historical conditions motivating present conceptualisations, introducing another set of questions that extend the very idea of what it means to be a girl in school mathematics: How can we work to disrupt the unquestioned and unquestionable founding arguments that underpin mathematics education's configurations of girls? How can we work to destabilise the promises of feminist emancipatory politics? Attending to those questions exposed the illusion of the permanence of what we have come to know about gender difference in school mathematics.

The text sketches an alternative politics for girls in mathematics, one that differs from its predecessors not only in the vision it provides but also in the level and style of intervention it advocates. In this work I have tried to perform a different kind of analysis, drawn from a tradition that is current in political philosophy, but has not yet received much attention as a framework in mathematics education. My point in doing this has been to suggest how it might be possible to produce new knowledge about girls in school mathematics through critical reflection on the processes by which knowledge is and has been produced. Critiquing in this way does not produce knowledge in any enduring sense but marks an acceptance of the vulnerability of all knowledge claims. This final chapter reviews the strands of this inquiry and uses them as a means for contemplating the future.

## The Question of Gendered Subjectivity

Let me begin by saying that responding to the question of gendered subjectivity, in a way that takes into consideration the social and theoretical conditions of a new century, has been less than straightforward. It has entailed questioning the construction of gender as a hierarchical binary and pointing to the political processes by which the category 'girl' has been produced. In the first place that task has required an understanding of how the 'girl' became an historical problem for mathematics education. Revealing how mathematics education sought to regulate and domesticate certain forms of knowing about these girls led to the necessity for an archaeological study of the academic discourse of girls and school mathematics over the past five decades. That process traced the early rush to define the girl's difference and the sources of her oppression, as well as the determined efforts to announce with certainty her universal condition in school mathematics.

This led to a critical examination of the discourse's foundationalist history, which involved a critique of its explanations through a scrutiny of its primary premises, its categories and the integrity of its subject. The various strategies employed by the discourse have all founded on the issues of gender difference as a conceptual and structural phenomenon, naturalised and prior to culture. Competing visions have taken one side or another of the opposition: same/difference. More frequently, the argument is for equality, and the problem revolves around how to recognise and refuse terms of discrimination, and act on behalf of girls without confirming the 'reality' of a separate female sphere. Those few who have argued more recently for difference claim that gender difference is the inescapable product of individuation. Their project of making experience visible uses experience as an explanatory tool for gender difference even as it uses gender difference as an explanatory device for the asymmetries of male and female experience.

Documenting the story of girls around the 'natural' girl has been simultaneously a highly successful *and* a limiting strategy for mathematics education. Its success lies in the accessibility and apparent neutrality of its presentations of 'truths' about girls in mathematics. These narratives sit comfortably within the traditional disciplinary framework of mathematics education, working according to rules which permit calling old narratives into question, when new evidence is discovered. Here the status of evidence is unambiguous since evidence is said to be referential, a true and accurate reflection of the real. By writing the story as one of remediation, or as an expansion of existing categories and topics to include girls' ways of knowing, the implicit belief is that the notions of equality and difference are beyond dispute. But what is important here is that taken-for-granted narratives of the girl in school mathematics sidestep issues of legitimation, because the orthodox notions of practice to which they are bound preclude

the possibility of historicising the same/difference binary. This draws attention to the problem of power and the ways in which gender difference are established and institutionalised. Not only do the narratives fail to examine the political processes by which the meaning of gender difference is developed and contested; they also ignore the effects of those processes.

Rereading the story of girls must acknowledge that inequities persist even when structural institutional barriers are removed. My argument is that this is *not* the result of flawed practices by those seeking equal representation and equal treatment but of the inability of the liberal-humanist discourse which underwrites foundationalist usages of the 'girl' in school mathematics, to conceive of the category 'girl' without confirming or reversing its hierarchical position. The descriptions which it offers do not have the analytical power to address and then to change existing historical formations. Moreover, it is not possible to pose the very question of girls' gendered subjectivity within the epistemological position commonly taken by the disciplinary field of mathematics education. Despite its profound achievements, by implicitly endorsing normative definitions of unalterable sexual difference, the tradition regulates its epistemological subject by practices and standards that rule out the very possibility of critical intervention. This raises the question: Is it possible to conceive of a notion of students in school mathematics that is not embodied and gendered? By this I mean: Can we expand the concept of student so that it is not constructed in traditional gendered terms?

That task required that I read below the surface text of democratic access and inclusion of girls in mathematics schooling in which the universal 'girl' disavows her own locality and the conditions for local intervention. It demanded a reconsideration of the girl as essentially fixed, prior to culture, awaiting signification into language and culture via the masculine. Simply giving voice to this reconsideration would not suffice. Hence I brought another discourse to bear on the mathematics educational regime and took the risk of outlining, at some length, Foucault's social theory and those aspects of it which I considered salient to the development of a mathematics educational practice, and to a politics for girls in school mathematics.

In his exacting scholarship, Foucault draws attention to the governance and making of social subjects, not in the sense of capturing their reality, but of trying to understand the operations of the complex and changing discursive processes by which identities are ascribed, resisted, or embraced, and of the ways in which these processes achieve their effect simply because they are concealed. Thus a consideration of what it is that structures the discursive practices through which girls in school mathematics are constituted, requires that we look at the persons, the structures and at the discourses that unite them.

Foucault asks that we critically analyse the categories we most often take for granted: girls, boys, equality, difference, and the terms of progressive politics themselves. His theories have provided me with a different understanding of how the identity categories boy/girl, deemed necessary to mobilise a politics for girls, work to constrain possibilities for them. His work points to the intractable dilemmas confronting feminists working on behalf of girls in mathematics education.

Foucault asks that we rethink the notion of an individual who has experience, and think instead of the subject as *constituted through* experience. Gender then becomes, what Butler (1990) calls, a construction of "generative political structures rather than naturalized foundations" (p147). This points to the instability and malleability of the category 'girl' and to the ways this category is articulated. In that sense, the category 'girl' can never be reductively biological, but must function as a cultural marker of gender. Experience in this definition is not the origin of our explanation, nor the authoritative evidence which guides what is known. But rather that which we seek to explain; that about which knowledge is produced. Through this conceptual process it is easy to see how equality and difference reposition themselves in deference to each other, continuously. What this means for the construct 'equality' is that it can never figure as an absolute or universal practice; in this new co-ordering it is more a withholding of the exclusions enforced against certain differences in respect to certain purposes in certain contexts and in certain times. This mobile notion of equality receives a clear expression in the issue of access to the profession of mathematics and in the question of leadership and power allocation. In the former sex differences were once a consideration but are now formally discounted, while with respect to the latter, female particularity was, as recently as two decades ago, commonly matched against male universality.

Shifting the focus of the girl in school mathematics away from an epistemological account of identity to one which constitutes her within practices and discourses, allows her to be seen as a consequence of certain rule-governed discourses. This governance is not fully determined because its process is through repetition, rather than sovereignty. Rather than shutting down the possibility of agency, the process turns the question around to ask how signification and resignification are made to work; that is, the question is about the investments the girl sees for herself in both the restricting and the enabling forms of each of the various discursive demands made on her about what it means to be a school girl in mathematics. The crucial lesson that feminists working for girls in school mathematics must take from this is that subverting the taken-for-granted notion of girls' identity within the discipline is indeed possible. If we take on board Butler's (1990) argument discussed in Chapter 4 (cf pages 94-5), then the possibility of defying the complex injunction of

being a girl in school mathematics lies in a space found within one of the discursive pathways through which the injunction itself was configured.

Thus the girl in school mathematics cannot maintain 'integrity' prior to her entrance into this conflicted social field. I tried to understand how this played out for the girls in my study. I found Foucault's suggestion of the subject as a site of conflict or of negotiation, useful here. If one regards the girl in school mathematics as a site - an historical location or marker - where crucial political and cultural contests are played out, then it makes little sense to conceive of the girl as capable of transcending history and somehow able to recover her 'authenticity' from the unwieldy effects of discursive regimes of power. This leads to the notion of *paradox* which has framed this text since its beginning. Thinking of the girl as a place or location enabled me to acknowledge that she is constructed in complex and multiple ways over time. Many factors constitute her subjectivity, and this subjectivity is, of necessity, paradoxical in its expression.

Following Foucault, I think of gender as a regulating fiction, as a particular construction that produces identities and regimes of truth. But this, of course, is not how the girls in my study see themselves. By implicitly employing the notion of gendered identity as a stable inner core made manifest in 'experience', they think of themselves as unified. They have inherited this notion along with all the contemporary allegorical, sociological, psychological, historical and dismissive stereotypes about it. They use this naming because it gives them an identity. It gives them something 'authentic' about where they come from, where they stand, how they are desired and described, and in what terms. The problem for me was how to theorise the various modes of intelligibility that constituted these girls as subjects in school mathematics.

This is a different problematic to much of the research undertaken in mathematics education, which attempts to naturalise 'experience' through a belief in the existence of an unmediated (and necessary) relationship between words and things. By shifting the problematic of this project away from this endeavour, onto the actual *practices of signification*, I am arguing that all categories of analysis become contextual. This means that the epistemological rules and practices themselves are held up for scrutiny, which allows for an analysis that takes the epistemological mode itself as one possible and contingent signifying practice. This would open up for questioning the certainty promised by its explanations and the impartiality of its researchers. What it might also reveal is how the educational research tradition normalises large numbers of people through imposing categories that situate individuals as being the site of the problem. Thus the story of girls in school mathematics that I wanted to narrate is enacted as a critique of this conventional approach to mathematics education and of the ideology it supports.

My modes of critique deployed Foucault, drawing on his ideas in a very situated micro-analytical study of girls, as theorising in transit. In the Foucauldian approach, girls are portrayed as the tellers of experience, in which every narration is a social, structural and historical construction. Given that, what I heard the girls say is a constrained, provisional, nonunitary and situated version, one determined by a complex grid of histories and formal and informal discourses. This version maps onto their private talk and conversations with me. Reworking Foucault's linguistic and discursive tools required that I take that *partiality* into account and that has been my intent throughout the analysis, an intent to which the reader was drawn in this work's title. To reconfigure the girls' talk with the imperative of partiality forced me to look for competing discourses of experience, rendering to each of them an irreducible status. Granting a non-foundational status to experience opened new possibilities for analysing discursive productions of educational reality as complex, contradictory processes.

It forced me to use language differently. My analysis did not promise a holistic account, modelled on orderly relationships inherent in a rational and divinely originated world, because my aim was not for resolution of conflict. My move was away from linear teleology and more in keeping with the proposals of Lyotard and Baudrillard: episodic and unpredictable connections as depicted in information and communication networks whose dispersions operate without a sense of foundational essences. Using language in this way, I tried to produce a story which traverses beneath the texts of five decades of empirical mathematics educational critique. It did not seem appropriate to narrate what the girls said as it unfolded, because their hesitancy at one moment and their apparent confidence at the next, alerted me to a constant refashioning of their identities and investments as they were lived and rearranged in private and interview talk. Accordingly, I tried to hear what wasn't being said, and tried to read the unsaid against what was said.

This meant that I had to pay attention to my own researcher reactions - both conscious and unconscious. It would have been easy to ignore the contradictory and sometimes difficult things that were being said, but this ultimately would have interfered with my dealing with the emotional significance of these issues to the girls. I believe that had I not been aware of my own part in the material and attended to its place in the analysis it would not have been possible to provide the analysis which I have. What I found was that on hearing the tapes over and over, that some of what the girls were articulating had been issues in the past for me. Their pleasures and their pain became mine to the extent that I was surprised and upset when I heard later that Rachel had left school before completing Year 13.

I have presented vignettes of three quite different girls across the mode of private and interview talk, and through a range of discourses. Glimpses of the gendering processes which are at work through language on these subject positions reveal an intimate connection between their investments and desires and the gendered position made available. Mathematics as these girls live it, bears little relation to the social 'realities' of girls in mathematics which circulate in strategies of policy in government and in schools. Whether those 'realities' are established outside male domains as excluded or within those bounds as deficient or central, the issue remains the same. These various positions attest not to the reality of girls in mathematics but to the social fictions which are incorporated into the truths through which girls in mathematics are created, governed and regulated as objects. Mathematics, as the girls in my study have lived it, presents a real problem for a radical politics of difference.

Over time, patterns of subjectivity emerge revealing both similarities and differences between the girls and within each girl. I have endeavoured to write of them not as an embodiment of stability and universality, but to see each in relation to a variety of significant others: their family, their teacher, the students they sit near in class, their friends outside the classroom door. Mathematics has been a part of their schooling since they turned five years old, and it is taken to another level as they enter into a new world of calculus. As in their earlier mathematics classes, these girls are not only working with the technicalities of mathematics practice and with the complexities of the discipline; they are also, among other things, exploring their mathematical positionings in gendered society. Reappraising their place in mathematics requires their constant attention, as one discourse competes with another for various definitions and values. They respond to these competing discourses by developing various standpoints and constructions of femininity, and by the presentation of their selves as gendered persons to others within the classroom.

For the girls the classroom provides one of many locations for the constructions and reconstructions of the self. To some extent classroom practice may be seen as discursively aligned to the production of 'the real' girl which claims to tell the truth about girls in school mathematics. This knowledge enables certain behaviours to take place and then reads these behaviours back as 'true', producing a normalised notion of the girl in school mathematics. For Foucault this truth is powerful because it is precisely what regulates people in the Western social order. Girls in mathematics can, by this, be seen as implicated by powerful scientific truths which circulate within the school's community. Yet these truths do not have the full measure of girls' gendered subjectivity precisely because subjectivity is an interactive weaving together of *many* complex selves in relation to the complex selves of others. The teacher and other students are implicated in these

discourses. Clearly then the social construction of gendered subjects in mathematics is in some ways created by the teacher and other students, all of whom are informed by their own histories of what it means to be a girl in mathematics and all of whom offer either compliant or conflicting representations of gender, or some form of both.

Girls' lives have a past, a present and a future, and these lives have a consciousness as well as a realm of fantasy. Listening to what others say and do can give the girls glimpses of the worlds that might be available to them. These glimpses come not only from those practices within the classroom walls, but also from those of the school itself, their families and friends, the media and the worlds of fashion, music, leisure, and consumerism. Regularly these discursive practices offer notions of self-defining qualities for female students. The way in which girls take up these regulating practices is demonstrated in the clothes they wear to school, the stationery they bring to the classroom, their hairstyles, their whole-body movements, their gestures, their speech and actions, and in their unspoken thoughts. They are inscribed by these practices by making choices of compliance or resistance either through their materiality or through their imagining. To that extent, the discursive practices operate differently for each of the girls. The choices they make constitute their own subjectivity.

As a social practice, school mathematics itself is a site for the construction of ever-changing subjects. Incorporating new gendered positions, in relation to contradictory old ones, is an ongoing process for all students. Contestations take place over what students call each other and how they present themselves in face-to-face encounters in the classroom. Through these discursive battles the girls are all able to take up in the classroom some of the subjective positions which were denied them in everyday life. They do this by slipping in and out of the conflicting gendered discourses they engage in during their time in the classroom. Granted, their positionings could sometimes be described as passive, docile, and submissive. Yet at other times the girls positioned themselves as active, aggressive, and assertive. This process is expressed in their speech through metaphor, represented in Derridean language 'as the yet unnameable', and gestures towards an understanding of gendered consciousness, unable to mark its own constitutive limits.

I take up this point in suggesting that the social practice of school mathematics can be theorised as the conscious taking up of sanctioned subject positions *and* the conjectorising of those subject positions which are regularly closed to girls. It is in this slippery space, where the speculative and expressive converge, that transformation can occur. From this I argue that school mathematics operates as both a constraining and enabling practice; one that can be theorised as transformative social practice. My interpretive risks in accounting

for these girls and their changing relationships to others, to language and to power will hopefully lead to new understandings. There is no certain solution, no packaged pedagogy, no common classroom; only more and still more critical readings of texts of action, and the texts of girls' learning in school mathematics.

Precisely because all three girls were deeply invested in the essentialised human subject, such theorising may not make much sense to them. As girls in school mathematics they came to the research already populated with others' intentions, with others' forms of knowledge, and with others' desires, pleasures and fears. They all saw themselves as individuals with a real and essential core, whose outer skins are merely a series of roles which can be cast off to reveal the true and knowing self. Like most students they viewed the classroom as denying or inhibiting those real selves. More particularly, they considered that mathematical experience comes about not by theories, but by actualised practice, during which time the true mathematical self manifests itself. Given that, it is difficult to say whether the girls could hold onto an understanding of themselves as an invention of discourses and as fragmented subjectivities. They would view their mathematical practice as authenticating representation. In that my work employs theories which call promises of representation into question, a tension inevitably is created.

My point, in undertaking this school-based piece of research, has been to explore gendered subject positions in the construction of new knowledge and a radical feminist politics for the schoolgirl in mathematics. In it I attempted to make links between girls' subject positions with epistemological positions, political agendas of feminism, and with Foucault's poststructuralism. Gender enabled me to think about the ways in which hierarchies of difference have been constituted in mathematics and where possibilities for change might arise. Only by describing and understanding how gender is enacted in the mathematics, shaped both through contestation and collusion with various regimes of control, could I hope to develop knowledge of gendered subjectivity.

Much more could be said about the girls in my study. I cannot offer a total vision. Whilst some have searched for the definitive category that will finally explain inequality in mathematics between the sexes, my work offers a different perspective and argues that gender provides both a useful way of thinking about school mathematics and of theorising politics. All I can offer are my own uninnocent readings of girls' classroom experience, a gesture towards gendered subjectivity as an unstable construct, and the offer of a politics of the provisional. For my part, admitting to unclear vision is not an acknowledgment of defeat in the search for a universal explanation of the schoolgirl in mathematics. Instead I would argue that universal explanation is not, and never has been possible precisely because there is no privileged position from which one can speak

without one's own discourse being itself put into question. The idea of universal explanation was produced and nurtured by the Enlightenment ideals of progressive growth. But that discourse acknowledges neither the context of discursive practice available to girls nor the ongoing contestation and reconstruction of girls meaning making.

By focusing on a very small number of girls and their engagement with mathematics, inevitably many other areas and issues concerning girls and mathematics have had to be left aside. My intent is that this current work will serve as a launching pad for future work that aims to go some way towards reddressing those omissions. The expectation is that other future postmodern inquiries will pose fresh questions and shift both our understandings of gendered subjectivity and our sense of what might be possible for a politics of girls in school mathematics. My point here is that it is not so much asking about the meaning of gendered difference but the asking of a question about which we have not previously thought to ask. What I am at pains to stress is that this work is *not* a refutation of all that has gone before it on girls and mathematics. Libertarian and reconstructionist approaches in this field are both important and valuable projects because they bring critique to bear on what is perceived to be arbitrary forms of power. They *had* to take place and reveal their engagement with a universal mathematical experience of girls before I could begin to question their theoretical privilege and suggest a new way of thinking of and acting on behalf of girls in school mathematics. This new way encourages us to think of gender difference as a *political resource*, and as constructed through the social realm.

Historical conditions change. Different meanings will be attached to girls in mathematics as a result of new political commitments. As this work goes to print, traces of an emergent panic over boys' underachievement confound issues concerning gender in ways that contribute little to actual boys *or* girls. For this reason it is most important to retain and develop a poststructuralist discourse for dealing with forms of masculinity and femininity as they are performed, contested, negotiated and resisted in the current educational system. This allows for an understanding that does not position students as passive victims of discrimination, but which makes the processes and dilemmas, by which gender is constituted, visible for educational personnel to examine and create a space for change. At the level of social vision new emancipatory agendas will legitimate certain issues, at the expense of others, within particular discourses. Although Foucault's work did not in itself contain specific recommendations for the development of specific political practices concerning girls (or boys) in school mathematics, it nevertheless rules out some approaches as being politically undesirable as well as impossible. What emerges from this is that at the level of research and policy making, there needs to be a shared

commitment to understanding and exploring what is possible for girls. This commitment must suggest a politics which includes, at the very least, a recognition of ambiguity, contradiction and complexity at its centre. In this I am not implying that the theoretical work over meanings is unimportant, only that it is insufficient.

A start can only be made from where we are now and that position includes Enlightenment values. The idea of inventing new ideals would be foreign to Foucault since, as Sawicki (1991) has noted, he does not deny us the option of drawing on those of the Enlightenment; he merely points out their potential dangers and asks us to recognise these. Advancing a progressive politics for girls then would require us to be mindful that there is not any *one* central site of liberation. It would also require us to remain alert to the way in which new modes of self-understanding may potentially reinstate aspects of that from which they were struggling. This dilemma can never be resolved by a simple appeal to general principles of equality, and whilst a reevaluation of practice might revolve around such principles, they need constant interpretation and re-interpretation.

It is in this sense that Foucault's "practices of freedom" can be viewed as constituting a positive notion of freedom. What this suggests for mathematics education is that we need to consider regulatory practice concerning girls in school mathematics, with an experimental and cautious pragmatism towards the ways in which these practices are interpreted in particular contexts. It is then that we might acquire the means to make choices about how to speak, and write, and teach in ways that move toward the kind of arrangements in school mathematics which we desire.

A tactical progressive politics for girls in mathematics historicises practices. It identifies the internal relations of those practices, seeking not to explain them but rather to expose them. It does this by considering the way in which discourses "form a practice which is articulated upon the other practices" (Foucault, 1991, p70). This requires an analysis of the power/knowledge relations constituting the field, in order to see how power is exercised, to see whose voices are silenced, marginalised or excluded, and to establish how this might be open to change (Weedon, 1987). This moves questions of subjectivity beyond the stance of total knowledge towards a consideration of the constitutive constraints and the possibilities of gendered positioning itself. If the problem of gender in school mathematics is to be rethought, if new knowledge about sexual difference is to be produced, then we must also be willing to rethink the history and the politics of girls in school mathematics. This text is a contribution to that end.

## What can Educators and Teachers take from this?

Without a doubt Foucault's set of rhetorical and generic gestures has been a useful strategy for me in considering gendered subjectivity. However, this is not necessarily to say that it is useful for the task of classroom teaching and it is not quite so clear what would be gained by moving this new understanding of sexual difference onto concrete social and cultural issues of teaching practice. And unless we as mathematics educators are able to locate the theoretical ideas worked on in this study within actual classroom practice, his poststructuralist theorising will continue to operate at a high level of abstraction which fails to engage with crucial issues surrounding teaching practice. The importance of the relationship between research and teaching practice was raised at the ICMI Study Conference on Research held in Washington, DC, in 1994. Bishop reported in his summary of the proceedings, published in 1998, that the real concern for mathematics education research practice is in "relating ideas from research with the practice of teaching and learning mathematics" (p33). This section is a response to that concern.

The issue that arises is: is it possible to think about teacher education and classroom teaching practice which puts Foucault's ideas to work? What kind of classrooms should we try to create? What becomes of a politics of agency for girls when there is no essential subject? One response is a nihilistic approach. In this approach the claim is that Foucault's theoretical flourishes, with their focus on power relations, on constant deferral of meaning, and on precarious subjectivity, are undoubtedly all helpful moves beyond a position which attempts to identify one true and universal meaning about girls in school mathematics. However the nihilist slides this crisis of subjectivity into a void of fragmented subject positions, and argues that educators and teachers are left with no motivation for intervening in anything educational whatsoever. The free play of meaning that this engenders leaves practitioners questioning their ability to exert significant influence and offers no alternative but a retreat from political engagement. The educational practice, that originally seemed so in need of realising, renewing or securing, tends to disappear into its own deconstructionist irresolution.

A more productive approach is to take as a starting point Foucault's important theoretical and political arguments in his work "The History of Sexuality" in order to produce a *new attitude* towards mathematics educational practice: *one that relates to actual concrete modern conditions yet is not constrained by modernist thinking*. What this demands is not merely that we make those modern foundations more transparent and potentially problematic since critical reflection has not much negotiable currency beyond itself. Rather, we need to describe a transformed discourse of teaching practice as a mode of

action - one that reworks the key ideas of Foucault's poststructuralism for a reconceptualisation of agency and the emancipatory vision; one that meets the intellectual and cultural conditions of our times yet is neither sceptical nor arbitrary in its pronouncements.

Posing the question of poststructuralism's utility in this way is to argue in the first place that it is impossible to sustain the presumption of essentialism that is central to standard notions of agency: the presumption of a universal essence of human nature upon which the rational autonomous subject was founded. Teachers and students are social selves and these social selves are not essential, but historically variable. A poststructuralist approach has no need to think in terms of the teacher and student who uses reason progressively to discover the truth about the world of mathematics teaching. It would hold that this way of thinking is approached through the wrong questions. Teaching practice cannot be viewed as an enclosed category, for it is always interwoven with gender and other sociopolitical locations.

If, instead, we formulate practice around a non-essentialist notion of the subject, then agency cannot be seen as the embodiment of a universally valid social order, meeting universal standards that guarantee its success. Teachers are constituted as subjects in discourses, and disciplinary practices and also knowingly or not, contribute themselves to the process of turning themselves into particular kinds of subjects. Thus teaching practice becomes a contingent human project, socially constructed through discourses, and no longer mandated through an appeal to *a priori* foundations. Drawing on Foucault, I argue that it can be conceived of as a profoundly complex constellation of historical, political, sociocultural and knowledge power relations, some of which are connected, some of which are mutually exclusive. From these multiple locations and from diverse intersections with specificities other than institutional setting and student composition which these structures of power and dominance play into, the world of teaching figures quite differently from one teacher to another.

Second, abandoning the Enlightenment concept of an undifferentiated human nature and of human reason is not necessarily to argue for a rejection of the idea of agency. Rather it is to acknowledge that a commitment to the aims and values which derive from the idea even today continues to be the most appropriate we have for mathematics education. It is, however, to argue for a redefinition of agency which is relevant to contemporary life in the classroom. Formulating agency around a non-essentialist notion of the subject enables us to rework the concept beyond its purely descriptive category to one that acknowledges that teachers' work is produced in relations of power. In its redefinition agency assumes an analytic function through which to explore the way in which teachers

act and give meaning to their experiences and activities. It is to shift the question from asking 'what can be done' to one that examines the constituting social relationships in operation. As Valerie Walkerdine (1990) maintains "teachers are not unitary subjects uniquely positioned but are produced as a nexus of subjectivities in relations of power which are constantly shifting, rendering them at one moment powerful and at another powerless" (p3).

Shifting the question would yield an investigation that looks closely at technologies (or practices) of the self - those rules of conduct the individual practitioner sets herself intentionally and voluntarily. Conceiving of agency as contingent and 'multi-centred' allows teachers to render problematic their most firmly held assumptions while still acting in the world. In other words in formulating agency in this way a critical investigation of the teacher's socio-cultural situation of how he/she is implicated in oppressive classroom formations and power relations is able to be married with a capacity for self-governance. But thinking of agency in these terms is not merely to talk about exercising critical judgment of the discourse of mathematics education in both its structural and processual forms. In no way does it imply that the teacher cannot resist discourses. What presents is the possibility of finding a new impetus for the undefined work of freedom - *the possibility of transforming political relations through the production of new discourses and new forms of power and new forms of teaching practice.*

Clearly it is not very helpful to think of agency and interventionary measures in terms of emancipation from oppression. An understanding of the teacher does not demand an investigation of 'oppression' per se, but requires an analysis of the processes (both internal and in relationship to others) and the discourses that come to bear to constitute her as teacher and those that constitute her students. It is only through a close attention to the historical determinacy of these process that educators can begin to ask: Whose voices are heard and whose are silenced? What are the power relations that open or close access to classroom conversations? How can conditions be changed for those who have been silenced to come to know, feel and experience safety in dialogue? (Ellsworth, 1992) The focus then moves to making the existing relationship between mathematics education and society more transparent, and on exposing the tensions and contradictions between current practice and the discursive and material changes we consider necessary. The emphasis is on first laying bare and then disrupting established patterns of meaning and power relationships.

To make sense of the life of an educator and teacher engaging with issues central to the poststructuralist project in mathematics education is to fight against a conception of teaching practice as static and recognise that work experiences and the histories which are

brought to bear on them are partial realities, always open to contestation. It is to fight against hierarchical imposition in relationships with others and be prepared to challenge the configurations of power that traditionally have existed between teacher educators, teachers, pre-service teachers and students. Concretising the possibilities for change in schools is to construct classroom practices that do not impose a rigid and disciplinary set of values on students, but instead recognise the dangers of imposition and allow others to feature as privileged speakers. It is to make a commitment to engage in political struggle in the meaning of mathematics teaching itself, while simultaneously acknowledging that to speak of transformative social change is to question the very meanings of empowerment and liberatory practice. It is to create a practice that transgresses and exceeds a knowable order.

If classroom life is to be affirmed as that which exceeds the efforts by which it is rationalised, constrained and subordinated to some higher goal, then teaching can be the seat of an affirmative power that opposes regulation. The intellectual task is to understand what structures of power inhere in what is conventionally known as teaching. That is, the task is to understand the way in which teaching is managed, crafted, extended and controlled; to understand how it is determined within the dense web of educational power regimes and to distinguish between disciplinary modes of power and the kinds of resistances that they occasion and spawn. But above all, the task of the teacher is to question the practice by which she willingly accepts questionable limits of knowing and acting, and to replace this acceptance with a sense of her own power to make decisions in the face of the educational apparatus and its discursive regimes that seek to deny her any sense of agency. Putting agency to strategic use in this way cannot be seen as some sort of free-floating idealism but an evaluation that refers to and derives from the political discourse of mathematics education; one which is continually open for revision.

Foucault's theorising is also able to create a politically constructive moment for teachers' work in the classroom. It is not a question of ascertaining the truth about the teacher or about the girl in school mathematics. For Foucault human nature is not a hidden essence waiting to be discovered, but an artefact. His theorising enables us to understand that the political possibilities for mathematics education are centred on the individual as both the site for a range of possible forms of subjectivity, and subjected at any particular moment to the regime of meaning of a particular discourse. It asks: What formative events have brought this present situation about? How are female students constituted as subjects of their own knowledge? How are they constituted as subjects who exercise and/or submit to power relations?

From the perspective of teacher education and teaching a whole new space for critical reflection on the scope and limits of freedom becomes available. What is laid bare is the possibility of moving beyond one's current self, and what one might be doing or thinking in concrete teaching situations. For the teacher this is insightful because it argues for problematising the roles of male and female students in the classroom and the power relations that influence who and what can count as 'knowers' and the 'known' (Miller, 1990). Granted this localised action cannot hope to perform a wholesale social transformation of gender relations because the meaning of gender difference is not fully defined within individual relations; rather it is referenced to larger social and institutional power networks. What it does mean, however, is that teachers can produce new knowledge that, in its own small way, can envisage new possibilities and their realisation.

In other words Foucault's later work provides the conceptual tools for a project of freedom, of going beyond the 'limits' that circumscribe one's own particular historical situation and circumstances. It enables points to be grasped where change is possible and desirable, and the determination of the precise form this change should take. It gives new direction to the undefined work of agency to be achieved by working at the limits that have been imposed on us. It is this which permits a more productive approach to the articulation and extension of the work of teachers. For in a perspective in which the individual practitioner is seen as not simply constituted but also invested and traversed by often uneven and inequitable relations of power-knowledge, then what becomes possible in relation to practice is something more than a history of a 'construction': it is rather the possibility of a history of an intervention through a commitment to social and educational change.

## Contemplating the Future

I have argued that Foucault's critique of inherited structures of belief and convention plays a central role in the new intellectual movement of our times. I believe that his ideas and those of others profoundly disrupt what we have come to know as research practice and that mathematics education needs to take this seriously. I suggest that given the contentious intellectual times in which we are now immersed, mathematics education needs to examine further the critical intimacy of its project with Truth. This is a provocative move on my part.

Mathematics education as a field of academic research has over the last few decades, as Ernest (1998) notes, become a major world-wide establishment. It has its own

institutional structures, discourses and practices. By rewriting the story of modernity, Foucault and other poststructuralists have, according to some commentators, substantially changed the rules of the research game. To understand this we need to look at how the modernist version of research in mathematics education defines its practice. Research which embraces modernist notions, engages the Enlightenment idea of progressive change, formulating its practice around the rationality and stability of researchers and upon noncontradictory subjects. It is intimately tied to a belief in the real and the representational. While remaining sympathetic to its commitment to changing the social order towards a more just, equitable and humane world in mathematics education, I suggest that there are some problems with the assumptions underwriting the modernist process. This is to do with what Phelan (1993) calls "the question of belief" (p1) in the real and in the relational.

In modernist theorising the real and the representational depend on a referential notion of evidence, claiming that research practice is a reflection of the real. Standard approaches to method exemplify the right use of reason and are the methodological paradigm for all truth claims. Seeing is the origin of knowing, the belief and expectation being that reality is somehow out there waiting to be captured and that the researcher is capable of producing the Truth. Given that poststructuralism's move is against this vision of Truth, it severely undermines its status. In poststructuralist versions Truth is taken as an effect of discourses. However, notwithstanding the persuasion of the poststructuralist challenge of epistemological positions and hierarchies, the mainstream in mathematics education remains powerfully entrenched within the institutionalised research tradition. Poststructuralism has provoked little interest especially among white Western intellectuals whose consciousness and positions are perhaps among its primary subjects of critical analysis. Undeniably few researchers are willing to abandon Truth for a position which maintains that Truth and grounded meaning in any final or transcendental sense has never been within grasp *and*, which simultaneously seeks to disestablish their own privileged positions.

As a subversion of received notions of subjectivity, representation, knowledge and power poststructuralism is undoubtedly threatening. Recent attempts to question the relationship of mathematics education with Truth have had to look to alternative concepts and ways of thinking. The social conditions of the twenty-first century, namely, the fragmentation of knowledge, the multiplication of disciplines, the expansion of research centres, the proliferation of information exchange, and the professionalisation of discourse, among others, all require us to do so. I make this point as a result of a sense that, unlike some other disciplines, many of those working in mathematics education are

unfamiliar with, and/or uninterested in, what the postmodern might mean in the domains and locations represented in their academic work.

What then might be an alternative way of conceiving the forms and functions of mathematics education research practice? A productive approach which does not abandon research altogether as a site for intervention, would seek to accomplish very different ideological and material work. It would not, according to (Britzman, 1991), concern itself with applying the correct technique, or with correcting what is taken as mistaken, or looking more intently. Indeed it would question the singular logic of presence which seeks out the real and the certainty in observation and the recording of behaviour. It would support the modernist desire to learn about educational settings and learn how to 'do' education better. But in doing this it would exploit the emancipatory project, in anticipating no final resolution.

This new imagination would, in Britzman's (1991) words try to "think the unthought in more complex ways" (p 236), envisioning new fields of possibilities, and new ways of writing the subject and the social. It would incite us not to accept the findings of an argument too readily. It would be on the lookout for tension between the social construction of normality and that which does not fit neatly within the bounds of its constructs. It would focus its action of local sites, on microcapillaries of power and oppression and on the multiple differences that characterise specific contexts and persons. It would link this localised knowledge to larger structural features (political, economic, and cultural) which have wielded power by means of tenacious domination, exploitation and oppression. In this newfound consciousness, the central concerns of formal education, Luke (1995-6) argues, become even more relevant. Who succeeds? Who fails in schools? How and Why?

To develop a poststructural awareness to the dominant features of research is to ask questions of power, economy, history and exploitation. Power then becomes a central concept in understanding what happens in mathematics classrooms. An understanding of power as relational and deeply implicated in knowledge production argues for an understanding of knowledge and truth as culturally, socially, and institutionally constructed and imposed. It also suggests that research which views teachers as the source of classroom power and knowledge, and research which maps out either a liberal-humanist definition of students as oppressed, or a constructivist notion of the student as origin of knowledge, are all inadequate approaches; approaches which need to be superseded by investigations of intersubjectivity, exploring the interaction among students and relevant others within the educational apparatus.

The researcher in the twenty-first century cannot claim to be the bearer of universal Truth any more than mathematical knowledge can be sourced from the depths of the student. Foucault advises the researcher to abandon authority "outside of power and within the truth" (Dreyfus and Rabinow, 1982, p130). His analysis of power points to the role of the researcher as organised historically in an assumed power structure in which the researcher is hierarchically prior to the researched. For the researcher to take responsibility is not to argue for the researcher's 'God's eye view' but to acknowledge a differential privilege constructed within contingent and imperfect contexts. This acknowledgment is not a desire to equalise or reverse the relation. Any shifts are always limited because institutional relations of power are in place which serve to constrain (without fully defining) what is possible. But it can help create a space in which these roles and relationships are questioned, where new possibilities are envisioned; a space in which the researcher reflects on what we are today, and how we have come to be this way, and the consequences of our actions.

Reworking the notion of research in this way promises a fuller understanding of the educational community and a greater sense of responsibility towards it. Its work sets itself against the constraints of authority, regularity and common sense in order to open up new lines of social discussion. It is a form of theorising which can look at discourses more usefully by making their in-built problems more visible. It asks what political work a discourse can do rather than what it says. This, it seems to me, is an enabling act, an empowering approach to the generation of knowledge. It is a form of knowing that can have powerful future consequences. It is a praxis of the present, an approach to inquiry that I have sought .

> The essential political problem for the intellectual is not to criticise the ideological contents supposedly linked to science, or to ensure that his own scientific practice is accompanied by a correct ideology, but that of ascertaining the possibility of constituting a new politics of truth. The problem is not changing people's consciousness - or what's in their heads - but the political, economic, institutional regime of the production of truth. (Foucault, 1980, p133)

# Appendix IV

## PARENT INFORMATION SHEET

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FACULTY OF
INFORMATION
AND
MATHEMATICAL
SCIENCES

# Mathematics Education Research

Dear Parent

The school which your child attends has agreed to participate in a research project relating to Mathematics Education. This project looks at ways Sixth Formers participate in and view mathematics. As part of this study students from your child's mathematics class will be asked questions about their attitudes towards mathematics.

DEPARTMENT OF
MATHEMATICS

In order to produce high quality research that is relevant to the wider community, it is important that as many students as possible from the class are involved in this study. Your child's participation would therefore be greatly appreciated.

Any information recorded on tape as part of this investigation will have no bearing on actual marks for internal assessment within the school or in end-of-year examinations. Participation is entirely voluntary, and if your son/daughter chooses not to participate this will have no adverse effects on examination marks.

Participants have the right to:

- refuse to answer any particular question and to withdraw from the study at any time
- ask any questions about the study at any time during participation
- provide information on the understanding that names will not be used and that participants will not be identifiable in any material produced from this study
- ask for the tape recorder to be turned off at any time
- access to a summary of the findings when the study is concluded

As part of the Privacy Act (1993) requirements, your consent must be obtained in order for your son/daughter to participate in this study. Please complete the attached consent form and return it to your child's teacher.

If you have any queries about the research, please phone me at Massey University on 356 9099, ext **7058** or contact the Research Supervisor, Dr Glenda Anthony, on 356 9099, ext 5336. Thank you for your time.


Yours sincerely


Margaret Walshaw

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**FACULTY OF**
**INFORMATION**
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**SCIENCES**

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**DEPARTMENT OF**
**MATHEMATICS**

# Parent Consent Form

# Mathematics Education Research Project

I have read the accompanying letter regarding the Mathematics Education Research Project, and I understand the purposes of this research.

I agree to my son's/daughter's participation in the study and for him/her to provide information to the researcher under the conditions set out in the Information Sheet.

I agree to the taping of this information on the understanding that my son/daughter has the right to ask for the tape recorder to be turned off at any time.

**Your full name** (please print) ............................................................................

**Your signature**............................................................................................

**Date**............................................................................................................

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