Talking and Taking Positions
An encounter between action research and the gendered
and racialised discourses of school science

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We must think that what exists is far from filling all possible spaces.
(Foucault)
Abstract
This thesis concerns processes of power relations in and about the science classroom. It draws on action research involving science and mathematics teachers in the Swedish upper secondary school (for students between 16 and 19 years). For the analysis, feminist post-structuralism, gender, and discourse theories (e.g. Butler and Foucault) are combined with critical action research methodology (e.g. Carr and Kemmis) and discourse analysis (e.g. Wetherell and Hall). The aim of the study is to make visible processes of inequality and to investigate how these are constructed in ‘talk’ or discourse about teaching and learning. The study grew out of teachers’ actions/small-scale projects in their own classrooms and so the study also investigates if and how action research can contribute to making visible, challenging and changing unequal practices and discourses of dominance. The first part of the thesis deals with this process and the analysis suggests that post-structural critiques of language and discourse are helpful in enabling actions to challenge inequities in the science classroom that currently exist. Five different articles constitute the second part of the thesis, two of which explore and survey research literature and argue for a need for more studies which investigate critically how science is shaped by specific social, cultural and historical contexts. Additionally, it is argued that it is important to focus not only on measuring differences among students but also on investigating how difference is constructed and how inequities can be challenged. The experiences and bodily feelings of what ‘race’ can do to gender (and vice versa) in a specific situation are recounted and examined in the third article which also invites different positions and complexity into the research field. The next two articles investigate how power and knowledge are produced, resisted and challenged in teacher and student talk within the action research project. The analysis draws on different discourses in contemporary Swedish society; for example a science discourse which produces school science (and its teachers and students) as high status, a gender equality discourse, a gender difference discourse, and an immigrant discourse which produces ‘immigrant students’ as problematic. Analysis of teacher talk reveals, for example, that long-established hierarchies and taken-for-granted values of school subjects in relation to gender reproduce advantage for some teachers but not for others, that teachers participate in the gendering of science subjects, and that changes in the teaching of science are resisted. Also students are located inside and outside the discourses they draw on, which qualifies or disqualifies them as ‘proper’ science students. Different borders are highlighted to show how students attach meaning to gender, social class, and ethnicity in different situations. Sometimes borders are produced inside bodies (the notion of the gendered brain, for example) and sometimes between cultures or according to family background. Resistance to dominant discourses is also visible in students’ talk and the ways in which teachers and students reproduce borders and exclusion in the science classroom through their practices. The analysis points out the need to initiate new research which can deconstruct among others, discourses of femininity and masculinity, the ‘immigrant student’ and school science.

Keywords: action research, discourse analysis, power relations, processes of inequality, science classroom, the Swedish upper secondary school
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Eva Nyström
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Articles included in the thesis


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The accepted articles in this thesis are published with kind permission of each publisher.
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PART ONE
Background
This thesis concerns processes of power relations in and about the science classroom and draws on action research involving science and mathematics teachers in the Swedish upper secondary school (for students between 16 and 19 years). Part One of the thesis provides the background to, and outline of, the research project and also contextualizes the schools involved. It further presents research questions, theories from which the analyses are read, and ethical issues related to the analyses. A major section of Part One focuses on the action research process which has been the subject of a range of papers presented in national as well as international conferences. This first part of the thesis ends with a brief presentation of five completed articles, which are woven into the discussion on results and conclusions.

The five articles constitute Part Two of the thesis although each can be read independently. Articles I and II introduce the reader to the research field, while the third is a reflexive essay about how as a researcher, my understanding of ‘race’ came to be important to my study of gender - as evident in the discourse analysis reported in Articles IV and V. These latter two articles draw on discussions of students and teachers who participated in the action research project, which was the principal starting point for the thesis.

Personal background
The research is grounded in my background as a practitioner. I had worked as a science and mathematics teacher for about ten years before I embarked on a university women’s studies course. The content of the course included feminist theories of science, gender studies and theories of power and seemed relevant both to my professional and private life. I took the course in connection with a major change in my personal life (I had recently moved with my family to a city where we did not know anyone) as well as dissatisfaction with my working life, and I was actively looking for another position. From my perspective as a science teacher, I had thought much about girls and science, for instance, about why girls dropped science on leaving secondary education. This ‘girl problem’ was one reason for my interest in gender studies. However, the studies opened up other possibilities, for example, of questioning the nature of science itself and of understanding science as a social construction. These were also issues that I had struggled with at a more personal level since I had many experiences of being positioned as a ‘different’ or not ‘proper’ as a science teacher (and student). Further, the women’s studies’ courses I studied helped me personally to understand why the situation in the school had affected me so much that I felt compelled to leave. After more years as a teacher (in another school) I decided to extend my studies. Specifically, I wanted to investigate the relationship between gender and science, and to explore how gender is ‘made’ in the science classroom. I therefore jumped at the chance when the opportunity arose for me to study for a doctoral degree in the National Graduate School of Gender Studies (at Umeå University) in 2002. I have never regretted this

1 See Appendix 1.
decision although it has led to major changes (good and bad) in my professional and personal life. The next section provides an indication of possible connections that can be made between feminism and action research.

Connections

My experiences as a teacher plus feminist epistemology from my studies, led me to favour a methodological approach which prioritises participation, democracy, and social critique (see e.g. Keller, 1985; Harding, 1986; and Hubbard, 1990, about a feminist critique of theory of science). A potential for this was found in feminist action research. Two main components of action research are its closeness to the praxis it aims to study and its goal of challenging and changing practice, for example, in terms of patterns of inequality (see e.g. Schön, 1987 and Carr & Kemmis, 1986 who discuss the relation between theory and practice). Furthermore, it was a sense of responsibility, of not wanting to leave teachers outside the research process and of not doing research about education, but rather for education (Carr & Kemmis, 1986) that was my initial motivation to do action research. The connection between power and knowledge and between institutionalized power and science (vetenskap), the existence of hierarchies within science, and the curiosity about whose knowledge counts most (Foucault, 1980) were additional motivations for me to do action research. I recognised, for example, that teachers’ knowledge and concerns were important for the development of my own research questions.

Action research shares many characteristics with feminist research such as the aim to challenge and change discriminatory power relations (Berge, 2000) although feminist theorizing and practice has been “a relatively unacknowledged force” within action research (Maguire, 2001/2006:60). There are also many different definitions of feminism (Robinson, 1993/1997). Here, I draw on a three-fold conceptualization of feminism: as a politics (and struggle against women’s oppression), as a critique (as in debates within women’s studies about the nature of knowledge), and as a practice (e.g. collaborative, non-exploitative, non-hierarchical) (Weiner, 1994; Berge & Weiner, 2001). Further, the aspirations of feminist critical practice, it is argued, are that it draws on experience, has its roots in practice, is reflective and open to change, and in the classroom, is imbued with equity, non-hierarchy and democracy (Weiner, 1994).

I also want to argue here that research which aims to raise equity issues in the classroom is likely to have more impact if practitioners, in this case teachers, participate in the research process. Since my research interest concerns power relations in schools, and my own school experience and interest lies in the science classroom, my ambition was to combine these two and also collaborate with practising science teachers. (The background literature on the intersection of science, science education, gender and feminist research is provided in Article I while Article II reports on the current status of and trends in the field of gender, equity and science education research).
Questions which guided the action research project’s first phase, and which were explored with the teachers from the beginning included:

- How can we understand gender relations and inequalities in the science (and mathematics) classroom?
- What happens in the science classroom when different actions challenge unequal teaching and behaviour?
- How can school science become more gender-inclusive?

The action research project involved seven teachers in total from two upper secondary schools in Sweden and took place during the school year 2003-4. In the next section I present the two schools and their beginning involvement in the project (see also Articles IV and V).

The school context

Sweden is a multiethnic society, and as in other countries, immigrants and minorities are drawn mainly to the larger towns and cities despite recent government dispersal policies (Hällgren & Weiner, 2003; Andersson & Bråmå, 2004). The two project schools are located in two very different areas. ‘South School’ is culturally diverse, mainly taking students from immigrant backgrounds, and is located in a city in the southern part of Sweden, while ‘North School’ is more socially homogenous, has students mainly from families long settled in the area, and is located in a town in the northern part of Sweden.

Until the mid 1990s South School specialized in technology and recruited mainly boys but for a decade or more has offered two national programmes in business studies and science. At the time of the project there were approximately 700 students and 55 teachers in the school, an equal mix of boys and girls, of whom over 70 per cent had foreign backgrounds. Two experienced female teachers, of chemistry and mathematics, agreed to participate in the project. The teachers said they were interested in gender equality in particular because they had, several years beforehand (1998-2000) participated in a project which aimed to support girls in laboratory work in chemistry by organizing them into sex-segregated groups.

At the time of the project, North School had approximately 1100 students and 100 teachers, offering seven national programmes of which the science programme was one. In recent years, recruitment of natural science students has decreased, and ‘immigrant students’ are few in the school overall. The five teachers who chose to participate in the project specialize in physics (two women, one man), chemistry (one woman), and mathematics (one woman). Their length of service varies from a

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2 These figures can be compared with the overall population of the city of which 26 per cent were born outside Sweden, and eight per cent within Sweden but with both parents from abroad (2006). For Sweden as a whole about twelve per cent of the population has a foreign background (SCB, 2005). The largest ‘immigrant’ groups in the city are, in descending order, the former Yugoslavia, Denmark, Iraq, Poland, and Bosnia-Herzegovina.
few to many years, and before entering teaching the teachers at both North and South Schools had worked either in other schools, at the university, abroad, or in other professional areas e.g. engineering and forestry.

**Project organisation and development**
Following initial discussions with the participating teachers, a number of small scale projects were planned, which mainly focused on making science teaching more inclusive. I met each group of teachers on a regular basis; for planning and evaluating the projects, discussions of readings and sharing ‘critical moments’. My multiple roles included that of group leader, critical friend, and facilitator.

While initially the *small scale projects* (the actions) were my main research interest, two other areas emerged as possible targets of analysis; *discussions* in the project (i.e. reflections on the work going on), and the action research *process* itself (with its aim of bringing together research, action and reflection). These new possibilities forced me to rethink the demarcations of my research (and thesis). I moved away from mainly concentrating on the small scale projects and their outcomes (which the teachers continued to work with), towards exploring how power relations are discursively produced in the teaching and learning of school science and mathematics. This shift of focus was nevertheless part of the action research process - which is cyclical in conception and which encourages reflection and change to the research process itself (see e.g. Elliot, 1991). The action research process also generated themes and questions which provided the content for student focus groups later in the research (this is detailed in Article V).
Theoretical outlook

The theoretical perspectives adopted in the thesis draw on a range of feminist and post-structuralist approaches, all of which reject totalizing, essentialist, and foundationalist ways of seeing the world. Instead it is argued, social categories such as gender, social class, ‘race’/ethnicity, and sexuality are ‘made’ or constructed, for example in ‘talk’ about school science and its practices. Moreover, gender is theoretically, analytically and practically impossible to isolate from other socially constructed systems of inequality involving, e.g. social class, and ethnicity (Mulinari, 2004). The analysis, therefore, focuses on power relations, how they are shaped through discourse, and how meaning is made in different situations and contexts. This understanding of power relations, it will be argued, will lead to a more nuanced and productive perception of how inequalities in schooling occur and therefore how it can be challenged and reduced.

Ontology and epistemology

My understanding of social reality, i.e. my ontological point of departure, is constructivism. What we know about the world and what we understand as ‘real’ is something we construct socially in interactions with each other. Therefore, I understand phenomena and categories, things that we usually take for granted, as socially constructed and under constant revision (Grix, 2002). Further, my understanding of how knowledge is made and what constitutes knowledge, i.e. my epistemological view, is inspired by feminist scholars such as Evelyn Fox Keller (1985), Sandra Harding (1986), Donna Haraway (1988), Ruth Hubbard (1990), Anne Fausto-Sterling (1985/1992), among others who critique the claims of science as objective and unbiased. Like the French philosopher and historian Michel Foucault (1980), they show that knowledge is related to inequalities of power. For example, they highlight how research which fails to consider the gender-, class-, or ‘race’-position of the researcher contributes to andocentric, ethnocentric, and heteronormative biases in science. This critique was important in that it provided me with an insight into identifying more precisely my key questions in relation to school science. How, for example, is school science constructed; what knowledge counts as important; whose questions are seen as interesting; and in what ways do school science content and teaching reproduce gender, ‘race’/ethnicity, social class, sexuality (and so on) in the classroom and elsewhere?

Theories of gender

‘Social constructivism’ is a key concept in gender theory in the sense that objects and characteristics are seen as socially constructed rather than as ‘natural’ or essentially driven. In gender theory, gender is likewise conceived of as socially constructed. Although I agree with this, the use of gender to describe (various socially constructed) femininities or masculinities, and their differences can lead to

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3 This should not be confused with my personal ontological and epistemological position, where the word constructivism is seen as opposed to realism. (See also Carlson, 2001).
the construction of unitary and fixed categories which seem more likely to box-in than liberate. As Judith Butler puts it: “…not biology, but culture, becomes destiny” (Butler, 1990/1999:12). Therefore, I want to shift the concept of gender away from what is considered to be typically male or female, towards investigating how such understandings are constructed, for example, through language (Keller, 1992). It seems more productive to interpret gender as an active verb, i.e. as “active and interactive doing”, rather than in terms of “passive being” or “predetermined becoming” (Kvande, 2003:21).

Emphasis on active processes is also found in Butler’s concept of ‘performativity’. Butler claims that gender is a ‘doing’, but also that behind the expression of gender no gender identity exists, neither is there a doer behind the deed; rather “identity is performatively constituted by the very ‘expressions’ that are said to be its results” (Butler, 1990/1999:33). However, while social practices are performed, they also actively shape gender and other social categories. The body is at the centre of Foucault’s analysis of the struggles between different formations of power/knowledge, in the sense that he describes how bodies are ‘produced’ and disciplined (such as in the case of the criminal, the worker, the woman) (Foucault, 1977/1991). Notwithstanding, performativity is also a reiteration of the norm, a repetition (Butler, 1993:12). This repetition offers certain stability to gender identity as well as opening up possibilities for change (Butler, 1995; see also Rosenberg, 2005:16). A similar concept which has also been important to my analysis is Foucault’s notion of discourse which I shall return to later. The focus of this thesis is science students and teachers, not as specific individuals but in terms of their pedagogical construction. In project discussions, we worked hard to ‘do’ the science teacher and the student; and without intention, to gender, racialise and shape these two categories in different ways. Therefore, the above theories of how practices shape social categories and how ‘bodies’ are produced have been immensely influential to my understanding of how gender processes work in schools. Important also have been the possibilities for change offered in terms of how gender, ‘race’, social class and so on are performed, since they also provide hope for the realization of a more equal school, which was my main initial motivation for embarking on this form of research.

Despite the perception of gender as fluid and active, the materiality of practice cannot be denied; for example, in the sense that, teachers’ practices are influenced by local cultures, identities and material conditions. This paradox - gender as fluid but at the same time a social structuring mechanism - is a much-debated issue among feminist researchers (see e.g. Ferguson, 1991; Scott, 1996; Eduards, 2002). I tend to side with those who claim that both perspectives are needed, viz. “[w]e ‘are’ [women or men], and in parallel, we are ‘made’ [women or men]” (Eduards, 2002:43).4 Or, as Butler (1995) expresses it: “there is no ‘bidding farewell’ to the doer, but only to the placement of that doer ‘beyond’ or ‘behind’ the deed.” (p.135, original emphasis). Further support for this position comes from Connell (1987)

4 My translation: “Vi både ‘är’ och ’görs’ parallellt.”
who asserts that gender structures are expressed through gender practices. Gender structure, order, and regime individually and collectively, influence possibilities either towards stasis or change. Gender structures and practices are thus interconnected; there cannot be structures without practices, nor vice versa.

**Power relations and discourse theory**

Foucault’s analysis of power as relational is helpful in understanding these paradoxes and dualisms. According to Foucault (1977/1991) different types of power relations exist, depending on who or what is involved, e.g. categories of people, financial influence, physical strength, upbringing, support from institutions, and so on. Power is everywhere, shaped and emanating from interactions between individuals. However, different power relations also interact, support or obstruct each other, such that new power relations, techniques and mechanisms develop (Foucault, 1977/1991; see also Hörnqvist, 1996). Foucault underlines also that power can come from beneath, but that it also circulates; “[i]t needs to be thought of as a productive network which runs through the whole social body” (Foucault, 1980:119). Power at different levels - power between people in concrete situations (e.g. between students in school), institutionalized power, and societal power relations (e.g. involving ‘race’, gender, social class) - are therefore interconnected and mutually dependent (Foucault, 1978; see also Hörnqvist, 1996).

Stability and change seem to be the ‘red thread’ running through the different theories drawn on for this thesis, and also highlighted in discourse theories. Discourse psychologists draw attention to instability between discourses, analyzing how individuals build selectively on different discourses in different contexts. On the one hand, societal discourses frame discourse practices and on the other hand, are challenged by them (Foucault, 1978; see also Winther Jørgensen & Phillips, 2000). Analyzing discourse involves exploration of meaning-making, how it is organized, and as Wetherell et al. (2001) put it; how meaning is “sedimented into certain formations and ways of making sense” (p.3). It is inside discourse that things take on meaning. As Hall notes:

> The concept of discourse is not about whether things exist but about where meanings come from. […] since we can only have a knowledge of things if they have a meaning, it is discourse – not the things-in-themselves – which produces knowledge. (Hall, 2001:73 - this is Hall’s reading of Foucault, 1972).

To Foucault, all practices have discursive aspects, since discourse is about knowledge production through language (Foucault, 1971/1993). Furthermore, according to Hall’s interpretation of Foucault, knowledge is understood as working through discursive practices in specific institutional settings, so regulating the conduct of others.

> Just as the discourse ‘rules in’ certain ways of talking about a topic, defining an acceptable and intelligible way to talk, write, or conduct
oneself, so also, by definition, it ‘rules out’, limits and restricts other ways of talking, of conducting ourselves in relation to the topic or constructing knowledge about it. (Hall, 2001:72; see also Hall, 1992).

An important implication for the analysis is that it is not the subject but discourse that speaks and produces language and knowledge (Foucault, 1982/1983; see also Butler’s, 1995, discussion about the subject that is constituted in, and within discourse). This is crucial because the principal outcomes of the research concern how knowledge and power are made by discourse and not what specific teachers or students ‘say’. Foucault (1982/1983) uses ‘subject’ in two different senses, as pointed out by Hall:

First, the discourse itself produces ‘subjects’ – figures who personify the particular forms of knowledge which the discourse produces. [...] These figures are specific to specific discursive regimes and historical periods. But the discourse also produces a place for the subject (i.e. the reader or viewer, who is also ‘subjected to’ discourse) from which its particular knowledge and meaning most makes sense. [...] All discourses, then, construct subject-positions, from which alone they make sense. (Hall, 2001:80, original emphasis).

Thus subject can be seen both as personified discourse and as a position in discourse. However, as Davies and Harré (2001) recognize, individuals are not only the bearers of knowledge produced by the discourse but are also capable of exercising choice in relation to discursive practices. Agency, according to Butler (1995) is to be found at “junctures where discourse is renewed” (p. 135). This opens up the possibilities of agency, and the opportunity of drawing on different discourses, or choosing different subject positions in different situations.

The discourse analyses reported in this thesis (see also Articles IV and V) explore how teachers and students (as subjects) are inscribed in wider, societal discourses shaped by historical contexts, institutional regimes, and specific situations. The analyses further consider how teachers and students are positioned in discourses, and how they draw on a variety of subject-positions which give access to different interpretations, knowledge and power. One such position is that of the ‘other’, briefly outlined theoretically in next section.

**Theories of the ‘other’**

The French philosopher and feminist Simone de Beauvoir highlights the position of woman as the second sex, or the ‘other’ (de Beauvoir, 1949/1995), that is outside the norm of the (French, intellectual, middle-class) male. Theoretically, however, I wish to include categories other than gender in my analysis of how the other is constituted, and therefore have drawn on the concept of ‘intersectionality’ introduced to the Swedish research context by Paulina de los Reyes, Irene Molina, and Diana Muliniari (2002) among others. ‘Intersectionality’ highlights how different systems of power work together to produce categories such as gender,
social class, sexuality, and ethnicity which intersect in a fluid manner (de los Reyes & Mulinari, 2005; see also e.g. Crenshaw, 1995). Important also is the acknowledgement that different categories need to be understood in their historical and cultural context and therefore, of the impossibility of separating them from the intersections of politics and culture (a point made by Butler, 1990/1999, but long recognized by other feminist scholars such as Gayle Rubin, 1997, Nancy Hartsock, 1997, and Monique Wittig, 1997).

In relation to schooling which is the main site of action of this thesis, it has been particularly valuable to identify the various social processes through which the ‘other’ is produced, for example, through having a foreign background. In Sweden the notion of ‘immigrant’ (and ‘immigrant student’) tends to be used uncritically (Hällgren, Granstedt & Weiner, 2006). Some are ‘othered’, i.e. categorized as ‘immigrants’ because of their appearance, although they may have no experiences of immigration. Others are not seen as immigrants although they have immigrant experiences, because they are white or European-looking (e.g. immigrants from Eastern European countries). The problem with this way of ‘doing’ the ‘immigrant’ or this process of ‘othering’, is that borders (or barriers) are constructed between the norm group (here the ‘Swedes’) and ‘immigrants’ where those who accord with the norm have the power to define what is acceptable, normal, and so on. Therefore, in Sweden the concept of ‘immigrant’ seems to be strongly racialised, used often to describe people whose appearance, more than cultural, and/or ethnic background, render them as non-Swedish (Schmauch, 2006).

Racialisation or the process of racism, represents a process whereby biological characteristics such as skin colour are given social meaning and used to allocate people to different social groupings and in turn, to structure their social (and economic) relations. Thus, racism “entails the racialisation of the processes in which they [individuals] participate and the structures and institutions that result” (Miles, 1989:76). An example of this is the designation of schools as low status on the basis of the majority presence of students with ‘immigrant backgrounds’. A key point in this reasoning is that racism does not exist because of the existence of different ‘races’. Rather, ‘races’ exist because ‘race’ is a social construction due to racism.

Racism is seen by researchers as ubiquitous, i.e. existing everywhere, and in all societies, to a greater or lesser degree (Essed, 1991; Pred, 2000). Additionally, ‘everyday racism’ is a concept used to highlight individual experiences of racism as a routine experience at the same time as acknowledging the structural aspects of racism (Essed, 2005). The concept of everyday racism helps to shift our understanding of racism away from the comparatively rare examples of extreme

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physical violence and unashamed discrimination towards more frequently occurring subtle, trivial, taken-for-granted practices and incidents.

However, focusing only on experiences of the ‘immigrant student’, without acknowledging the influence of ‘whiteness’ (as in my own case) is also problematic. As a white person, I am implicated in institutionalised racism and have a possessive investment in ‘whiteness’ (McLaren & Torres, 1999). Such a privileged position, inscribed within political, economic and ideological inequalities also needs to be unpacked:

[S]ilence can mean denial and this denial can then lead to a lack of focus on examining whiteness, and its role in perpetuating power inequalities. [...] [Unpacking whiteness] may [make it] possible to see more clearly how gender privilege and inequality are expressed through racialised contexts, as well as vice versa. (Bhavnani, 1993/1997:34).

The concepts of racialisation and whiteness have been important to this thesis, for example, in terms of the analysis of teachers’ and students’ positioning in the science classroom, the intersection of different systems of power in that setting, and the formation and (in)visibility of new expressions of power relations.
Objectives and research questions
The aim of this study is to make visible processes of inequality and to investigate by means of action research, how these are constructed in ‘talk’ or discourse about teaching and learning in the science classroom. The study grew out of teachers’ actions/small-scale projects in their own classrooms. Thus this study also investigates if and how action research can contribute to making visible, challenging and changing unequal practices and dominant discourses.

Specific research questions include:
- What discourses are at work in the science classroom, and to what extent do these collaborate and work against each other through social practices?
- How do the discourses produce ‘subjects’ and construct ‘subject-positions’?
- What power differences are made visible through the analysis of discourse and discourse practices?
- What power relationships can be discerned in the action research process?
- To what extent has the action research process contributed to the eventual research outcomes?

Methods
At the start of the research, everything that arose from the specific action research and its process was considered as data. Therefore, all possible material was systematically collected and saved, such as correspondence, written documents, printouts of e-mails and tape-recording and transcriptions of group discussions. The research process was further documented through logbook writing (my own and that of the teachers). Further, the different small scale projects drew on student logbooks, video-taping of group laboratory work, analyses of text books and tests, questionnaires, classroom observations, and tape-recorded focus-group interviews with students. The methodology used in the project is outlined in the next section and the method of analysis for the teacher discussions and the focus group discussions with students on pp. 23-24 and in Articles IV and V.

6 By ‘discourses in the science classroom’ I mean discourses (and practices) visible in the classroom but also visible in talk about classroom situations.
7 See also Appendix 6.
Action research; methodology, process and findings

This section introduces action research as a research methodology and describes in some depth how I understand and have inserted different theoretical perspectives into a specific action research project. It also includes an outline of the project including some discussion of its lengthy initial phase, and also of design, progression and evaluation. It also discusses issues that emerged as the project was carried out.

Methodology

The main methodological approach taken, as already mentioned, is that of action research which is relatively new to Swedish school research (Carlgren, 2005; Weiner, 2004). However, there are different perspectives on what action research means. For example, while they conclude that there is no short answer to that question, Reason and Bradbury (2001/2006) provide the following working definition:

A participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview which we believe is emerging at this historical moment. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities. (Reason & Bradbury, 2001/2006:1).

They further point out one primary, and one wider purpose of action research:

- to produce practical knowledge useful to people in the everyday conducts of their lives
- to contribute through this practical knowledge to the increased well-being – economic, political psychological, spiritual – of human persons and communities, and to a more equitable and sustainable relationship with the wider ecology of the planet of which we are an intrinsic part (Reason and Bradbury, 2001/2006:2)

Action research is attractive because it focuses on peoples’ actions and social situations (Elliot, 1978), and is underpinned by a commitment to democratic social change (Walker, 1997). It also attempts to overcome the gap between research and practice (Somekh, 1995), and to redistribute power relationships within research away from the academics and towards practitioners (Schön, 1987). Theoretically, I identify most with ‘critical’ action research approaches which Carr and Kemmis

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8 Action research became popular in the 1980s among researchers on the lives of the labour force (arbetslivsforskning) (Carlgren, 2005. See also Carlgren, 1999). Recently, there has been a move in Sweden towards ‘praxisnära forskning’ which is interpreted as research close to practice, research in a practice, or research which takes as its starting point the view that knowledge is accumulated through practice (Orre, 2005).
(1986), among others, describe as rejecting positivism and other instrumental ways of viewing knowledge. Central to the discussion of action research (or ‘praxisnära forskning’) is the importance of the relationship between theory and practice, with different ideas expressed about how best to interpret practical knowledge compared to theoretical knowledge (Mattsson, 2004). For example, are the researcher’s and the practitioner’s knowledge-base distinctive because of their different interests in and perceptions of knowledge? Or, do borders between different types of knowledge production become blurred in the process of dialogue and interaction? Carr and Kemmis (1986) argue for a dialectic relationship between theory and practice, in which critical action research is able to aid the development of critical practice. Critical practice, it is argued, involves the integration of theory with practice through reflection on practical situations. It is hence:

a form of practice in which the ”enlightenment” of actors comes to bear directly in their transformed social action. This requires an integration of theory and practice as reflective and practical moments in a dialectical process of reflection, enlightenment and political struggle carried out by groups for the purpose of their own emancipation (Carr & Kemmis, 1986:144).

During the action research process, political practices and values fuse together, thus generating action aimed at change.

Critical action research and feminist research methodologies seem to have much in common (i.e. offering a critique of positivist research, guided by values rooted in practice and lived experience and committed to democratic research). However, feminists have criticized Carr and Kemmis for gender-blindness and for seeing teachers as abstract entities (Weiner, 1989; 2004). Therefore, it seems that a specific feminist perspective is important even if feminism can mean many different things. I have chosen to see western feminism as emerging in three ‘waves’ with the latest (third) wave occurring from the 1990s onwards. For some, ‘third-wave’ feminism provides “illuminating theoretical underpinnings for action research’s task.” (Weiner, 2004:640). This, as I understand it, means that interpreting gender as fluid and multi-layered helps us to move beyond dualism to ask different questions, and to perform new actions. So, instead of drawing on discourses of women and girls (or other oppressed groups) as ‘problems’ or ‘victims’, they are attributed with agency. There are also other parallels between post-structuralism and action research; for example, in the wish to deconstructing

9 Historically, western feminism is described as emerging in three main ‘waves’: First wave feminism (in the nineteenth and early twentieth centuries) was directed towards women’s access to education, jobs and equal rights. Second wave feminism (from the middle of twentieth century onwards) involved struggle against women’s oppression alongside the development of major critiques of scientific knowledge. Third wave feminism (from the 1990s onwards) following challenges from black feminist and post-colonial theorists among others, focuses on identity politics, re-conceptualisations of identity and agency, and reworkings of power as fluid and multi-layered. This wave of feminism views women’s condition as more complex and less passively victimized than hitherto articulated.
‘reality’, in not seeking to avoid complexity and in blurring the roles of researcher and practitioner.

More concretely, most action research is built on the following four elements:
- involvement of practitioners, in the study of themselves and others;
- creation of spirals of activity (e.g. idea > reconnaissance > plan > implement > evaluate > amend plan > implement etc.);
- utilization of small-scale research methods;
- development of alternative criteria for reliability, validity and research quality¹⁰ (Weiner, 2005:143).

Since action research starts with everyday experience and investigates the development of ‘living’ knowledge, the project process can be as important as research outcomes (Reuson & Bradbury, 2001/2006). Put differently, the process may itself generate unexpected yet important outcomes. To see how process became especially important in this project, the first phase of the action research process is presented in the next section.

**Initial project phase**

The first project task was to find teachers interested in collaborating in the research, the main aim of which was to make science more gender-inclusive. At this stage I was particularly influenced by Sandra Harding’s (1986) discussion of gender as appearing in culturally specific forms through which gendered social life is produced through gender symbolism, gender structure, and individual gendered characteristics. My initial idea was to study, by means of action research, the gendered construction of the science classroom and how science itself is connected to these processes. At the time, gender as a construction felt rather too abstract an idea to communicate to the teachers, so I looked for something more concrete as a starting point for the project’s coming actions. Gaell Hildebrand’s (1989) concept of gender-inclusive science seemed a productive starting point.¹¹ In October 2002, a leaflet presenting the project and its aims was sent out to head teachers in seven

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¹⁰ Action research, it is argued requires different criteria for reliability and validity compared to more conventional research approaches. Pritchard (2002) e.g. highlights that the researcher needs to inform practitioner about project’s objectives and design, i.e. provide ‘informed consent’. Varying types of validity are used by action researchers e.g. outcome validity (did it solve the problem?); process validity (was the activity educative and normative?); democratic validity (to what extent was the research undertaken in collaboration with all partners involved with the problem under investigation?); catalytic validity (the degree to which the research transformed the realities of those involved); dialogic validity (the extent to which the research can be discussed with peers in different settings) (Anderson & Herr, 1999; Lather, 1986).

¹¹ The concept of gender-inclusive science incorporates values and extends to prior experiences and learning, current interests, needs and concerns, and preferred learning and assessment styles, of both girls and boys. Gender-inclusive science education utilizes the strengths of all students, (e.g. co-operative work skills); creates space in the structure of the course to close differential gaps in prior experiences (e.g. tinkering with tools and machines); includes activities which reflect the reality of science as it is practiced (e.g. speculative, values-led, creative); and provides a curriculum which is not exclusive in its use of resources, and classroom interaction patterns (Hildebrand, 1989:16).
schools in South Sweden. The leaflet contained a short presentation of issues surrounding girls and science and introduced the concept of gender-inclusive science, alongside an invitation to become involved in the project, whether in a larger or smaller capacity. The leaflet also provided a short project description and information on planning and time tabling.

The second task was to make personal contact with head teachers (locally in the south of Sweden) in order to meet prospective participants and discuss their possible involvement in the project. This led in the end to several meetings with interested teachers in two schools. The head teacher at South School gave permission for two teachers to take part and it was agreed that they participate for one semester (August – December, 2003) though this was later extended (until June 2004). Contact with North School developed after a school lecture at the end of which the forthcoming project was mentioned. An interested teacher took responsibility for arranging a meeting with the head teacher, and later with a number of science teachers who eventually agreed to involvement in the project. In this school it was agreed that the project would extend over a whole school year (although again involvement continued after the formal end of the project).

Contacts with the schools were initiated through the leaflet (October 2002) and follow-up information meetings with teachers were also arranged (December 2002). However, the first ‘proper’ group meetings took place some months later towards the end of the school-year (i.e. May 2003). There were two reasons for the long initial project stage. First, I took part in a university exchange programme which involved my presence in South Africa between February and May. (My experiences of South Africa are analyzed in Article III as a reflective process that had an important bearing on my later interpretation of the outcomes of the research. See also Articles IV and V, and the theoretical section, pp. 8-10). Second, financial support was needed for the release of the teachers to work on the project, the achievement of which proved time-consuming. Eventually financial support came from the Teacher Education Faculty at Umeå University.

During the first project meetings at each school, I introduced myself, gave a short presentation about my understanding of gender, and shared my thoughts about the ‘girl problem’ in science (i.e. why does science attract so few girls?). Furthermore, I talked about the concept of action research, as well as previous research on science and gender, and also provided practical examples of ‘actions’ concerning gender and science from the literature. We also together drew up starting points for the project including ‘goals’, and ‘timetables’. Relevant academic articles were also exchanged and discussed.14

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12 See Appendix 2 for original wording - in the Swedish language.
13 See Appendices 3-4.
At these initial meetings, the teachers likewise introduced themselves and talked about what they expected from the project. They were also asked to choose the classes and students they wanted to work with in the project, the school subject they wished to work with, and the issues in they were most interested. The idea was that, adopting a gender perspective (we agreed) would help us identify which classroom changes might be attempted. We also discussed the value of writing logbooks, and in what ways as lead researcher, I could help the teachers in terms of design, implementation and analysis of interviews, questionnaires and observations and so on. The teachers agreed to begin their involvement by responding to questions e-mailed by me, on ‘gender and teaching and learning science’ and to return their completed responses by the next project meeting.\footnote{See Appendix 5.}

**Project design**

During the project year, I met the teachers at North School on a monthly basis and those at South School almost as often. The earlier meetings focused on the previously distributed questionnaire on ‘gender and teaching and learning science’, and ideas about feasible small scale projects in the different classrooms. The teachers were also informed that the project needed to abide by the ethical guidelines of the Swedish Research Council (Vetenskapsrådet, 1990). As well as group meetings, individual meetings with teachers were arranged at North School when called for. The two South School teachers decided to collaborate in a small-scale project so most meetings involved the three of us. The overall project design is shown in Table 1.

### Table 1. Action research project design, 2003/2004.

<table>
<thead>
<tr>
<th>2003/2004</th>
<th>Group meetings (once a month)</th>
<th>Individual meetings (when necessary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Discus articles about action research, feminism, gender issues, agree on what to do next</td>
<td>Discuss design of individual projects; planning and starting up small scale projects</td>
</tr>
<tr>
<td>Aug. – Nov. 2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 2</td>
<td>As above, but also discuss and analyse ‘situations’ and ‘critical incidents’ arising from project classrooms</td>
<td>Research in project classrooms; involving questionnaires, logbooks, video taping, interviews</td>
</tr>
<tr>
<td>Dec. 2003 – April 2004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 3</td>
<td>As above, but also evaluate and analyse what we have done and how to continue</td>
<td>Analysis</td>
</tr>
<tr>
<td>May – June 2004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since meetings and actions took place simultaneously, the idea was that they should ‘feed’ into each other with reflections from two sides (practice and theory) and help shape the research process into a reflexive spiral which provided all participants with the opportunity to discuss actively, reflect on, and develop new knowledge which would initiate new actions. How we actually got through the spiral is discussed in next section.
Working in the project

I also attended the teachers’ classrooms and presented the action research project to their students, outlining our different roles and the project timetable. The students were informed of their rights over whether or not to participate, and what participation would involve, in terms of e.g. interviews, and questionnaires. Students were also made aware of the ethical guidelines of the Swedish Research Council.

It soon became clear that time might become a problem in North School. The teachers were uncertain about what they wanted to focus on, or how to approach classroom research. So, as long as there were no classroom projects to talk about, project meetings were taken up with joint reading of literature (see note 14 and 16). Time was also a problem in South School with formal involvement for only one semester initially although this was later extended for six months. The small-scale projects and methods eventually chosen by both schools are shown in Table 2.

Table 2: Teachers’ small scale projects.

<table>
<thead>
<tr>
<th>School subject</th>
<th>Identified problem</th>
<th>Action / method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics (two teachers)</td>
<td>Students’ inaction and failure in the classroom</td>
<td>Small groups during lab. work / video-taping, logbooks</td>
</tr>
<tr>
<td>Physics</td>
<td>Aggressive atmosphere among boys in the teaching group</td>
<td>Working in ‘safe’ groups / logbooks</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Criticism of textbooks, unfair assessments</td>
<td>Analysing textbooks and tests / questionnaires</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Gender differences in approaches to chemistry problems, criticism of textbooks</td>
<td>Analysing textbooks and chemistry problems / questionnaires</td>
</tr>
<tr>
<td>Chemistry (two teachers)</td>
<td>Gender differences in approaches to laboratory work. Cultural diversity and language issues. Impact of different (written) instructions on inclusiveness</td>
<td>Trying out different sets of written instructions on same laboratory activities / questionnaires, observations</td>
</tr>
</tbody>
</table>

Throughout the action research process I kept a personal logbook for planning, to describe and evaluate the project, but also as a means of expressing more personal feelings. The discussions with the teachers were tape-recorded and transcribed. Initially, this was mainly used to gather data on the research process, and as an aid in preparing for forthcoming meetings. I needed, for example, to take up interesting ‘threads’ from previous meetings and introduce relevant readings and new ideas. However, over time, a huge amount of empirical material accumulated from the discussions which was then utilised for analysis. Slowly, I began to understand that it was possible to do parallel research: on the practical small scale projects, on the research process itself, and on the discussions about equity and the ways we were
‘doing’ gender and other socially constructed categories in our ‘talk’ about practice.

As mentioned above the two teacher groups diverged in their activities. While North School focused more on readings and (theoretical) discussions, South School teachers seemed more interested in classroom research, and the ideas it generated. Also, the form of discussion changed over time, as project participants came to know each other better. The introduction of ‘critical moments’ was a key point in North School, enabling a shift of focus towards questions of power and equity in the science classroom. Also by drawing on critical moments I was able to communicate interesting themes and debates from one group to the other, back and forth as it were – which became a form of triangulation (Elliot, 1991). The concept of ‘critical moments’ used in the project concerned particular experiences from different school (and other) situations, captured in the memories of participants, which were ‘collected’ and shared throughout the project.

The discussions within the two teacher groups also generated themes that were later used to stimulate discussion in focus groups with students at South School. The reasons for only doing interviews with students at South School were firstly, that the teachers in this school specifically wanted to work in this way and second that I had worked in their classrooms more extensively than at North School, and consequently felt more relaxed with the students. The content of the focus group discussions was likewise tape-recorded and transcribed. The processes of analyzing data from both teachers, and student focus groups are outlined at the end of this chapter. (See also Articles IV and V which discuss the interpretations that were made of the teacher and student discussions). The next sections discuss the outcomes of teachers’ projects, and the action research process itself.

Outcomes of the teacher projects
Due to lack of project time, it proved impossible to engage in any in-depth analysis of the teachers’ small scale projects. Also, I had made the decision to refocus the orientation of the thesis to investigation and analysis of the ‘talk’ emanating from the teacher and student groups. However, this is not to say that the small scale projects were of less importance or that they were unsuccessful. Rather, the work and engagement with the project of the seven teachers were immensely impressive and have impacted positively, though to a differing extent, on school and classroom practices. (For more information on the outcomes of the school-based projects, see Appendix 6). In terms of my own research interests, however, several challenging issues emerged during the period of the action research process, the most important of which are discussed in next section.

Challenges within the action research process
This section highlights the challenges thrown up by the action research process. I draw in particular on Foucault's concept of discourse (see the theory section, p. 7-8) to explore the extent to which different positions were taken up and given, and how different power relations were negotiated between participants.

‘Marketing’ or publicising the project presented a major challenge in the initial phase of the project (Logbook 3, 021202-04). When first approaching schools I took up the position of researcher and drew on the ‘science discourse’ to underline why ‘my’ project was important for schools.17 The science discourse empowered me to be more confident and made my entrance into schools relatively easy; similarly in later discussions with science teachers I moved into the ‘science teacher position’ to underline that I was not an outsider but instead ‘one of them’. I also drew on the action research discourse to assure teachers that the project could provide them with useful and worthwhile research.18 However, different discourses of what counts as ‘real’ research were apparent; for example, for some science teachers action research did not seem able to deliver reliable or valid ‘scientific’ results; i.e. it did not meet the standards of objective, generalisable or measurable research (Logbook 3, 021204).

Another challenge was finding financial support for project teachers, which was necessary because in Sweden, staff development is mainly compulsory, takes place in non-contact hours, and usually occurs over a specific week in each semester. If teachers wish to become involved in development work on a more regular basis, they need to be ‘bought out’. Since action research is demanding of teacher time, the support of head teachers who saw the benefits of project participation in terms of the whole school rather than individual teachers was particularly welcome. In the case of giving financial support, however, there was some resistance from head teachers who drew on discourses which positioned school research as not specifically about developing school practice, and who therefore argued that funding and sponsorship should come from the academy rather than the schools (Logbook 4, 030526).

Making a distinction between school research and school development led to a range of different issues, for example, that there are different kinds of knowledge, different ways of understanding the relationship between theory and practice, different interests and knowledge-bases with respect to how a research group can be handled and negotiated with, implicitly and explicitly, and questions about the ability of theory and practice to co-exist. While certain discourses reveal action research

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17 The hegemonic science discourse in Sweden produces school science as an important subject of study, not only for the individual student but also for the economic development of the country (see Articles IV and V for more details of this discourse).
18 Discourses on action research methodology produce it as democratic research, and as a bridge between research and practice which displaces the power away from (academic) researchers to (practitioner) teachers (see the methodology section of the thesis, pp. 13-15).
research as democratic and participative, in the sense of empowering teachers to investigate their practices, I observed the resistance of teachers to this designation. Although I thought I had communicated with teachers effectively about action research methodology, I understand now that introducing action research is not only a question of information. Rather, a process occurs of coming to understand, and also accept action research, since it both redistributes power over the research process (from researcher to practitioners) and also requires power to be used productively which in turn needs time and commitment. There seemed to be substantial lack of communication between the teachers and myself, in the middle of which the research provided an instant space in which to re-negotiate our positions and what we actually wanted to do as researchers.

An e-mail dialogue between two of the teachers and me towards the end of the research period, reveals how we (re)negotiated our positions when trying to explain what was happening in the project (e-mail dialogue, 041023). In this discussion one teacher compared our different roles in the project arguing that in our meetings we were performing teacher (my position) and students (the teachers’ position). Further analysis of the discussion also shows that we negotiated between varying positions, e.g. typical teacher – student positions, and more ‘equal’ positions offered in the discourse of action research. While, at some point I had the ambition to transform our group discussions into ‘free-ranging conversations’ and therefore refused to take a lead, I met resistance from teachers who positioned me as a bad leader (Logbook 5, 031208).

The starting point for my research was, as mentioned earlier, the study of gender constructions of the science classroom, though my ideas of how to do this were rather vague. Moreover, I feared that teachers would be unwilling to be involved in a project with this goal, and I was also committed to the idea that teachers should start from their own questions. In that sense the action research discourse displaced power away from me towards the teachers. However, the teachers had difficulties in acknowledging the research as something important for them, which was reflected in their continual questioning about whether the research was providing me with what I needed for my doctoral thesis. One reason for this rejection of research ‘ownership’ might have been that teachers were unclear about whom the action research sought to empower. As I wrote in my logbook:

I have this uncomfortable feeling that the teachers do not understand the action research approach. Again they talk about me coming to their school and doing research in their classes. [---] They also asked me what I am going to investigate in the classroom. Oh, dear… do I know what I’m doing? (Logbook 5, 030828).

However my discomfort might also have been due to my fear of ‘losing’ my own research questions concerning gender and power.
I certainly have big problems trying to balance my own view on gender construction with the view of doing something concrete and at the same time something that the teachers can find helpful. The role of the researcher and the role of the teachers are not at all easy to be clear about. I feel I am extremely uncertain, vague, and obscure. (Logbook 5, 030115).

Also, I had some ideas from feminist and gender theories but was vague about how they best could inform practices in classrooms. In fact, promoting the democratic aspects of action research proved a good disguise of my own inability to make theoretical connections.

Frustration was something I carried with me throughout the project, mainly because of time constraints. In the end, lack of time of the teachers also made it impossible to involve them in the analysis of what had become a huge amount of accumulated empirical material. As the project ended, most of the small-scale projects had not yet been analyzed. Although some of the research ideas had travelled through the ‘spiral’ of action research and generated new actions, there was a feeling of not having finished what we set out to do, even though we had extended the project activity and our discussions beyond the life of the project. Some teachers continued project activity and began new investigations. For instance, two of the teachers went on to develop exercises which were more adjusted to students with Swedish as a second language. Other teachers continued to videotape students in group-work in physics in order to better understand the gendered nature of group-processes and how teachers can support students. One mathematics teacher continued investigating and develops her skills in assessment, particularly in relation to gender. The monthly group discussions also showed progress in understanding about power relations. For instance, we moved from concentration on gender differences towards, as I understand it, the more productive ‘doing gender’ approach, and even more, we moved from solely focusing on gender relations in our discussions towards incorporating other relations of power.

The action research project also provided the empirical material for two thesis articles, and the basis from which I was able to explore how power relations can be understood as discursively produced in teacher and student ‘talk’. How this empirical material was analyzed is discussed in next section.

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19 See Appendix 6.
Method of analysis

This section aims to complement Articles IV (on teacher ‘talk’) and V (on student ‘talk’) by providing more detail on the steps taken in the analysis of the discussions involving teachers and students. For the analysis, teachers’ and students’ talk is understood as a means by which different discourses are made visible, how teachers and students are positioned in discourses, and their variety of subject-positions. As Davies and Harré (2001) recognize, individuals are not only the bearers of knowledge produced by the discourse but are also capable of exercising choice in relation to discursive practices. They can therefore draw on different discourses, or choose different subject positions in different situations (for a discussion of discourse theory and discourse analysis, see the theoretical section, pp. 7-8 and Articles IV and V).

The discussions or talk in the (two) teacher groups and (six) student focus groups were tape recorded, generating in all 23 hours of taped teacher talk and seven hours of focus group talk. The tapes were transcribed although edited to exclude ‘small talk’ etc. I undertook both analyses simultaneously, starting first with the teacher discussions, then with the student discussions and then back again, and so on. Throughout the process of analysis different drafts were discussed in research seminars and one of the project teachers switched roles to become my critical friend and reader.

Below I present the steps taken in the analytic process (more or less the same for the two analyses), although it was a messier procedure than the bullet points imply. However, my aim in presenting the analysis in the form of the bullet points is to provide a sense of the analytic process growing out of the data. The analysis was also paralleled by theoretical readings of various kinds, such as various discourse analysis methods and theories, and how to use discourse analysis to explore talk in various research settings.

Stages in the analytic process

• 1st close reading of transcriptions, closely searching for grammatical and textual subjects and placing them in some kind of order (or table)
• Placing concordant subjects together; and building up ‘subject families’
• Describing ‘subject families’ drawing on background contexts
• 2nd close reading
• Filling out ‘subject families’ with more description, subjects and contexts
• Starting to write up the analysis. ‘Subject families’ begin to split into shorter sequences of talk
• Leaving the empirical data aside while moving the focus towards tracing wider discourses in society relating to education, school, science, equality, gender issues etc.
• 3rd close reading
• Arranging talk into themes
• Interrogating the talk of the teachers and students under each theme to identify the wider discourses that they are drawing on. Questioning whether the talk of the teachers and students highlight any borders between subjects and discourses and, if so, how these relate to wider discourses, and whether there are signs of discursive crossings over borders
• Identifying the discursive positioning of the teachers and students
• Searching to identify how different categories are discursively produced in the teacher talk
• 4th close reading
• Filling out the text analysis with missing links such as counter discourses

The ethical issues that confronted me in the action research and subsequent activities are the main focus of the next section.
Ethical issues
Research participants (teachers as well as students) received information about the project concerning their involvement, research aims, methodology, and use of data. Contact details (telephone and e-mail) of the main researcher (myself) were made available for students and research participants who were also assured that any information gained from interviews, discussions and/or other forms of data collection would be kept and presented in ways that guaranteed individual confidentiality and anonymity.

Action research, with its characteristic of a spiral process in which actions create empirical material which is then interpreted in order to generate new actions, seemed initially difficult to submit to discourse analysis. Although the possibility of using talk as the object of exploration became more attractive as the project progressed, how this could be achieved was decided only after the project with the teachers had finished. However, they had been informed about my intention to focus on talk in the analysis and were offered the chance to read the transcripts and participate in revisions to the draft analysis as it appeared. Only one of the seven teachers chose to engage in this part of the research which proved to be challenging, thought-provoking but also stimulating. These shared 'readings' of the data I want to argue, contributed to raising the quality of the overall analysis.

As already mentioned, my intention was to avoid ascribing meaning to individual participants, in particular by categorizing them as ‘immigrants’, ‘women/girls’, ‘men/boys’, and so on as though these are stable categories. However, discursive positions and power relations are remade and recreated over and over again in different contexts, and it can be productive, in some cases, to make visible how individuals are affected (positively and negatively) by positions in discourses and discourse practices. It is with this intention that categorisations were employed (though with the exercise of much caution).

Other ethical considerations worth mentioning are, for example, my endeavour to avoid contributing to the culture of ‘blaming’ teachers, or pointing a finger at anyone for expressing ‘wrong’ views. Instead, I want to show that, reflected through my analysis are discourses which make it possible for individuals (here teachers, students and researchers) to articulate particular beliefs, values and knowledges at specific contexts and time. Indeed, my own position and use of specific discourses helped shape what it was possible to say or not in the different groupings for which I was responsible. From this perspective, the thesis could be viewed as the staging of a performance that takes its point of departure as the theoretical perspectives through which I have chosen to view the research. The analyses and the way the research project is presented here should therefore be read as a suggestion, and as one possible reading out of many.
The articles in brief

**Article I: Reconceptualising gender and science education: from biology and difference to language and fluidity**
This article takes a genealogical approach (Foucault, 1984) in exploring research literature at the intersections of science, science education, gender- and feminist studies. The aim was to review the literature and trace taken-for-granted ‘truths’ and ‘objects’ in science education research back to older scientific practices and notions. More than just a review, this article provides examples from the rich body of literature selected mainly from studies carried out from 1980 to the present. The article first explores research on science practices in historical times, it then moves towards more recent science education research which measures differences, investigates inclusive science and seeks out more fluid perspectives. It is suggested that research which contains feminist- and gender perspectives provides different yet productive insights into the fields both of science and science education. There is a need, it is argued, for more studies which investigate critically how science is shaped by specific social, cultural and historical contexts.

**Article II: Gender and Equity in Science Education: a survey of selected journals (2000-5)**
This article examines four educational journals (*International Journal of Science Education, Science Education, Journal of Research in Science Teaching and Gender and Education*) for the period 2000-2005 mainly focusing on if and how articles in these journals address gender and equity. The aim of this survey was to identify key and emerging themes in the literature as well as to gain a sense of depth and extent of interest in the issues raised. Articles combining gender and science are rare, specifically those taking a more critical stance. Moreover, there are few signs of growing interest or an increase of studies on gender and equity issues, beyond comparing boys and girls, or applying simple binaries. Among articles which raise gender and equity issues the most common topic was ‘sex- or cultural differences’ largely focusing on measuring differences between boys and girls, or between students with different social backgrounds or cultures, in relation to science education. The other main topics for articles on gender were ‘classroom practices’, ‘epistemological views’ and ‘challenging stereotypes’. The article points out the importance of not only focusing on measuring differences among students but also on investigating how differences are made and how inequality can be challenged.

**Article III: Reflexive Writing and the Question of ‘Race’: an intellectual journey for a Swedish researcher**
This article uses personal reflection and reflexive writing to show how new perspectives on the typical Swedish gender standpoint were formed in the process of unpacking the notion of ‘race’ and its presence in South Africa. This intellectual journey challenged and forced new issues into the research project, and played a major role in how a perspective on ‘race’ was incorporated into the analyses. The text problematizes the notions of gender and ‘race’, and discusses the concept of
intersectionality while moving back and forth between description, interpretations and voice. The experiences and bodily feelings of what ‘race’ can do to gender (and vice versa) in a specific situation is recounted and examined. Gaining ‘race’ and losing gender is one way of expressing how an intellectual (and physical) journey can blur borders and allow different positions and complexity to enter the research field.

**Article IV: Teacher Talk: producing, resisting and challenging discourses in the science classroom**

This article investigates how power and knowledge are produced, resisted and challenged in teacher talk around an action research project aimed at making the science classroom more inclusive for all students. The analysis draws on different discourses in contemporary Swedish society; for example a science discourse which produces school science (and its teachers and students) as high status, a gender equality discourse, a gender difference discourse, and an immigrant discourse which produces ‘immigrant students’ as problematic. The analysis highlights the meaning-making practices operating in the talk of teachers and points out the instability between discourses as opportunities for change. Analysis of teacher talk reveals, for example, how long-established hierarchies and taken-for-granted values of school subjects in relation to gender reproduce advantage for some teachers but not for others, how teachers participate in the gendering of science subjects, and how changes in the teaching of science are resisted.

**Article V: Exclusion in an inclusive action research project: Drawing on student perspectives of school science to identify discourses of exclusion**

This article uses discourse analysis to analyse student voices articulated within focus group discussions carried out as part of an action research project. The article focuses on the extent to which students draw on wider societal discourses when they talk about what it means to be a natural science student. Students are located inside and outside the discourses they draw on, which qualifies or disqualifies them as ‘proper’ science students. Different borders are highlighted to show how students attach meaning to gender, social class, and ethnicity in different situations. Sometimes borders are produced inside bodies (the notion of the gendered brain, for example) and sometimes between cultures or according to family background. Resistance to dominant discourses is also visible in students’ talk and how teachers and students reproduce borders and exclusion in the science classroom through their practices.
Discussion
This discussion draws together findings from the different texts that constitute this thesis, with the main aim of indicating their implications for forthcoming research and practice. Since my theoretical understanding is feminist post-structuralism, which emphasizes that we constitute ourselves, our knowledge of the world, and constructions of reality through language and discourse (Nayler & Keddie, 2007), I have taken as my point of departure for this analysis, a portrayal of the discursive field which shows the different discourses active in the texts.

Picturing discourses in the field
The context for this analysis is the science classroom, or more precisely, an action research project focusing on making the science classroom more inclusive. More broadly, science teaching and learning, or science education provides the main contextual background. Discourse analysis methods have been used to map the different discourses that are taken up; first within teachers’ and students’ talk and then within wider discourses in the Swedish society (and perhaps elsewhere). Further, the research process has been ‘read’ or interrogated to identify and establish how the discourses work, the most important of which are outlined below.

Briefly, the dominant ‘science discourse’ produces school science (and its teachers and students) as having high status, while the ‘gender equality discourse’ emphasizes men and women’s similar values and responsibilities. The ‘gender difference discourse’ draws either on socialization or biology to explain visible sex differences, while the ‘feminist discourse’ critiques such notions of gender differences. Meanwhile the ‘immigrant discourse’ produces ‘immigrant students’ as the other, while school discourses of ‘individualism’ emphasize that school success or failure is wholly the responsibility of the individual student i.e. that all students have the same opportunities in school. Also distinguishable in the research process have been the ‘action research discourse’ which stresses democracy and the empowerment of practitioners, the ‘research discourse’ which emphasizes research as generalisable and delivering measurable outcomes and the ‘school development discourse’ which positions research as oppositional to the practical knowledge and needs of schools.

The above discourses constitute together the ‘discourse field’ through which practices and talk are further analysed. The extent to which the discourses cooperate with, and counteract each other in social practices, is the focus for next section.

Co-operating and counteracting discourses
This study has sought to show that dominant, social discourses are institutionalized within schooling, and are confirmed and maintained through language and practices. Discourses of science, gender equality, gender difference, and ‘immigrants’ combine to allocate differential status to schools, school programmes and subjects, and to empower teachers and students differently. For example, the
science discourse positions the science programme as the most important of all school programmes, which opens doors to students’ future studies and to high status professions. The discourse suggests that Swedish society benefits generally as more students take up science (and technology) and that if this does not happen, the economy will lose its competitiveness in the global market. Therefore, science education is produced as a key to preserving the resources to support the welfare state. In contrast, the immigrant discourse produces low status for schools with a proportionally high ‘immigrant’ intake even if they have more students taking science. The immigrant discourse positions ‘immigrant schools’ as having a different kind of science student, and as a more difficult working environment for teachers than the ‘normal’ school.

Whatever discourse is involved, it is seen as important to challenge the growing negativity among Swedish students towards science, technology, and mathematics, and their often low interest and poor examination results. The aim of encouraging girls to take up science accords with efforts to increase the numbers of science students. The ‘girl question’ however, also has a meaning within the gender equality discourse which emphasizes the importance of having equal numbers of men and women in all social and occupational positions. This goal is strongly stressed by ‘state-feminists’ in the different Swedish political parties, paralleling goals within the science discourse, and is probably one reason for the relatively even numbers of girls and boys choosing to enter the science programme in the Swedish upper secondary school. Currently it is seen as ‘natural’ for girls as for boys to study science in Sweden although this has not always been the case. Whether the entrance of more girls and women into science and related occupations has the potential to change the connotation of science as male is still an open question. However, the existence of the gender equality discourse shows that meanings and practices inside discourse can change ‘reality’; and furthermore, how different discourses can co-operate and build on each other to stimulate change.

The need of more students in science studies as articulated through the science discourse empowers the gender equality discourse by strengthening discourse practices such as ‘girl-friendly’ science, ‘gender-inclusive’ science and other ‘girls-into-science’ activities so as to make them meaningful and feasible. Thus the action research project started with the aim of challenging ‘ordinary’ school science and making science more ‘gender-inclusive’, thus echoing and drawing on these discourses. However, the project strategy changed over time towards making science ‘inclusive to all students’ not just girls, a change which seemed logical at the time, particularly since one of the two project schools is located in a culturally diverse area and contains students mainly with ‘immigrant backgrounds’. This suggests that the dominant character of the gender equality discourse in Sweden means that it is able to displace and render invisible other forms of inequality. For instance, even though language support is acknowledged as the key area for ‘immigrant students’, their main problems are often interpreted as culture, background, and family situation. ‘Immigrant students’ need, it is argued, to
overcome these disadvantages if they are to become competent science students. However for ‘immigrant students’ who do not succeed in science, their failure is seen to relate to lack of insight into their own potential or misunderstanding of the demands made of themselves as students by the science programme. Success is therefore seen as the responsibility of the individual ‘immigrant student’ and his or her family rather than of schooling per se. So, even though it seemed a relatively simple decision taken within the project to shift perspective from ‘gender-inclusive’ to ‘inclusive to all students’, the decision made visible the strength of Swedish gender equality discourses and their underpinning by discourses of the immigrant as the ‘other’. Indeed, the acknowledgement of gender power relations rendered other power relations invisible, or at least, less open to challenge. For me personally, a journey to South Africa raised my awareness of how my ‘race’ and ‘whiteness’ in certain situations could overshadow the gendered nature of my body (see Article III). The sense of being more racialised than gendered, the sense of gender and ‘race’ as fluid and interacting within my body, the sense of being positioned as powerful or powerless: all enriched my theoretical understanding of how different power systems intersect. It also made me aware of the impossibility of focusing on power relations without acknowledging that different power systems work to make life more rather than less complex.

In the context of this thesis, the gender equality discourse and the different practices aiming to facilitate girls’ entrance into science, also build on the gender difference discourse, which takes differences between the sexes as a starting point. My interpretation of this discourse is that it involves two explanations of why gender differences exist. On the one hand, gender differences are explained as rooted in biology, and on the other, as a social construction. Whatever explanation used, the gender difference discourse runs the risk of producing gender as a dualism, as can be frequently seen in gender studies of science education (see Article II). Thus treating gender as a fixed female-male dualism, appears to limit the exploration of more complex and contradictory gendered positioning and relationships. Used in the classroom, the gender difference discourse confers meaning on and upholds the hierarchy between school science subjects, in the sense that subjects are interpreted as masculine and feminine and therefore as reproducing inequality in power relations. However, the immigrant discourse is able to disrupt particular forms of gendered power relations. For example, the immigrant discourse displaces the common expression: ‘boys are successful in science because of their intelligence and girls because of their hard work’ so that a more gender equal position is created for ‘Swedish’ girls while the ‘immigrant students’ are produced as needing to work harder in order to succeed.

Thus far, this section has highlighted how discourses co-operate with and counteract each other in the process of giving meaning to social practices. The next section considers how discourses produce ‘subjects’ (e.g. the science teacher, the science student), and construct ‘subject-positions’ from where meaning is produced that makes sense to the subjects (Foucault, 1982/1983; Butler, 1995; Hall, 2001).
Subjects and subject-positions
The school is an institution with its own hierarchy and power relations. Following a ‘foucauldian’ reasoning, teachers and students can be seen as subjects hierarchically positioned at different levels and with formal, institutionalised rules of conduct. The discourses surrounding what it means to be a teacher and what it means to be a student are fluid and changeable, however. Over the years, for example, the discourse of the teacher as the authority in the classroom has been replaced by a discourse which produces teachers as guides or tutors, with the aim of making the classroom more democratic and sensitive to the learning of the individual student. Even though such discourse changes can displace the teacher–student power relationship, the formal institutionalised role of the teacher remains for the purpose of testing and grading and thus continues to allocate the student to a subordinate position.

The analysis of teacher and student talk carried out for this thesis (see Articles IV and V) suggests that in the school context, the science teacher and student are produced as high status. This status is deeply-rooted in traditional notions of schooling, as institutionalised knowledge which gives the science teacher a strong voice in the teacher collective and creates expectations of great achievements from the science student. Furthermore, the science discourse produces the science programme as the most important of all school programmes and as containing complex, abstract and difficult subject content, which need science teachers of the highest possible intellectual capacity. This is because the science teacher is responsible for the care and fostering of clever students, and needs to be able to discipline them into new ways of thinking and shape them into new generations of scientists.

The shaping of the mind of the science student is a strong student discourse, also visible in the talk of teachers where the question is posed of whether the science teacher is born with a specific way of thinking or disciplined to think that way. Notions of being born or bred to think scientifically reveal different discursively produced positions and power relations. For example, it is argued that through the discipline of becoming a scientist, the female science teacher puts her femininity at risk, i.e. femininity disappears when ‘real’ science thinking appears. Even though men and boys also clearly need to be disciplined into becoming scientists, masculinity is invisible in this discourse which produces science as ‘naturally’ male. However, drawing on the gender difference discourse, female qualities (and/or experiences) as produced as key aspects if science is to change, i.e. femininity is read as valuable in the sense that it is only women who have the agency to make science more gender-inclusive. That science remains male however is not disputed. A gender difference discourse which takes difference between the sexes as a starting point allows for meaning to be formed about why, for example, more men teach physics, more women teach biology, and why it ‘feels true’ that boys are cleverer than girls in mathematics and more able to understand abstract things. A gender difference discourse suggests power relations between girls and boys which make it meaningful that girls are more attracted to
chemistry than boys although boys are more often seen to be superior in chemistry. While the gender equality discourse has clearly contributed to opening up of the male arena for women and girls so that they feel ‘normal’ when they choose to study science, they are still confronted by gendered discourses which position them as, e.g. different, uninteresting, not good enough, not a ‘proper’ science student, or as ‘the other’ in terms of being a science student or teacher. It seems that as the science discourse creates or disciplines students into becoming scientists, it also produces gender relations, gives gender meaning, and makes gender visible through pointing out difference.

The notion of being born with a scientific mind reveals yet other sets of power relations. For instance, social class, and ethnic relations interact through the immigrant discourse which positions the student with an ‘immigrant background’ as associated with under-educated parents. In contrast the ‘naturally’ able science student is positioned as reliant on high parental level of education. The analysis shows clearly that gendered and racialised discourses play important roles in the construction of the science teacher and student as they continuously produce borders within which the ‘proper’ scientist is made. However, gender, class, and ethnic relations are not the only power systems in operation in school science contexts. Power relations between teachers and students, for instance, play an important role in constituting subject-positions although they mostly are interpreted as ‘silent’ or disappear into the interconnections between other power relations. For example, the science discourse disrupts power relations between teacher and student in the sense that male students position female science teachers as unqualified, unauthorized, and unskilled. However, the student/teacher position is so often taken for granted that it is likely to be more difficult to deconstruct. However, as we shall see, borders are also contested and challenged by different students and teachers.

**Challenging borders and taking new positions**

The analysis of the teacher talk and students’ discussions shows also resistance and that subjects challenge borders and draw on counter discourses. For instance, there is resistance to the student-as-superior position provided by the science discourse and continuously repeated in teachers’, parents’ and school-mates’ talk of the science student as cleverer and more ambitious than other students. This position is resisted through humour and assertions for example that anyone can do science, that other school programmes offer complementary perspectives to the science programme and that rote-learning used in other programmes is more demanding than the logic and abstract thinking of science courses. However, the analysis also shows that teachers’ and others’ discourse practices allow the science student to feel comfortable in the position of superiority and that this comfort is a direct outcome of the disciplining of the (‘proper’) science student.

The positioning of the ‘proper’ science student shows in particular that power relations and borders allow differentiation between categories of science students, and also how students and teachers who are positioned as outsiders can challenge
and resist their positioning. Discourse practices such as sighing, laughing and deliberately displaying ignorance not only make gender visible but indicate those who are not ‘proper’ science students and teachers, by implying that they are unqualified and unskilled in science. Such negative positioning can be refused, however, for example by feminist discourses which highlight and criticise the way in which gender works, thus offering teachers and students the power and agency to take up other positions.

Likewise the ‘othering’ of ‘immigrant students’ creates barriers between students by attributing meaning to family background in relation to whether academic success or failure is predictable. A counter discourse reveals however that neither ethnic background, nor gender or social class carries this meaning; rather, success is seen to depend on the efforts of the individual student.

The analysis of teacher talk also shows that there are frequently contradictory explanations and interpretations concerning the need for changes to the teaching of science subjects. For example, teachers claim to want to challenge the ‘fogginess’ and lack of understanding surrounding school physics instead of preserving its status, at the expense of comprehension among the students. The teachers also question why linguistic stringency and purity is understood as oppositional to femininity, and if there really exists a contradiction between femininity and the language of science. However, the science teachers who are committed to challenging ordinary and ‘male’ teaching styles, for example by using ‘simpler’ language, and different working methods experience resistance from students and other teachers, specifically if they are seen to pose a risk to existing scientific values of abstraction, difficulty and masculinity.

The project process
The action research process contributed to the outcomes of this thesis in several ways. Most important perhaps, was the connection established between the reflective discussions and classroom practice. The teachers (and myself, as I also participated in the work carried out in the classrooms and played a part in the teachers ‘actions’) brought their practice to the discussions in form of reflections on ‘critical moments’ and data drawn from the actions taken. Insights from practice included, that different positions taken in the classroom impact on the interpretation of ‘critical moments’ (e.g. where I saw gender power others saw ‘race’ power, and where a female teacher saw weaknesses in her own teaching, a male colleague recognized only his students’ bad behaviour as a factor). Further, the construction of the student questionnaire showed the need to problematize the category ‘immigrant student’ and led to reflection on the meanings we attach to student background. As already noted discussions and critical moments from one school sometimes informed discussions in the other project school, which, in turn generated new actions and also changes to ongoing actions. The teacher discussions further produced themes which were used to stimulate the focus group discussions with students; likewise critical moments from practice were also used in much the same way.
Frequently the research process itself provided the main focus of group discussions where our different roles, positions and engagement were debated, no doubt causing some painful moments for some of us. It was also notable that the ability to redistribute (or give away) power over the research process requires that someone else is willing to have and use it; i.e. that power is relational (Foucault, 1977/1991). Further, the power relationships created between the participants through the action research process included a range of positionalities that were continually shifting, such as ‘teacher – student’, researcher, science teacher, colleague, critical friend. However, the greatest impact of the research process was to indicate the necessity of a shift in the focus of the research from gender to power relations and to the reformulation of the key research questions.

**Can change take place?**

School science discourses are used differently in different situations and sometimes operate in contradictory ways. Instability between discourses becomes apparent where discourses are challenged and undergoing re-formation, and it is in this instance that new patterns and practices emerge (Wetherell et al., 2001). Therefore, when teachers resist discourses which, say, produce the traditional language of science as male, and claim instead that it is equally feminine, or when they challenge and seek to change the discourse of school science as abstract, impersonal and difficult, it is shown that change is possible. Thus, future potential projects for teachers and researchers of science education could include the identification, exploration, and deconstruction of how changes in discourse impact on science classroom practice.

To end, this thesis has pointed to the need to deconstruct among others, discourses of femininity and masculinity, the ‘immigrant student’ and school science. However, teachers themselves also need to be able to “examine critically the social processes and discourses that shape their ways of teaching and their students’ ways of learning” (Nayler & Keddie, 2007:212). It is my suggestion that post-structural critiques of language and discourse can be helpful in enabling this, by revealing that knowledge, ‘truth’ and social as well as material realities shape school and classroom practices. It is to be hoped that by adopting this or similar research perspectives, teachers and their students will be motivated to take action to challenge the inequities in the science classroom that currently exist.
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PART TWO