

# Re-inscribing gender binaries: Deconstructing the dominant discourse around women's equality in science, engineering, and technology

*Alison Phipps*

---

## Abstract

This paper tracks and attempts to unravel a persistently dominant discursive construction of the problem of women's under-representation in science, engineering, and technology (SET) education and work: the idea that the interaction of gender stereotyping with the masculine image of SET disciplines and workplaces prevents girls and women from choosing SET subjects and going into SET careers. The discursive framework of 'Women in SET' will be examined at both macro and micro levels as it operates in the field of activist and pedagogic activity that has grown around the issue since the 1970s. A Foucauldian analysis will be applied in order to explore the kinds of subject positions this framework enables and excludes. It will be argued that the 'Women in SET' framework re-inscribes the gendered binaries that have at a symbolic level defined girls/women and SET as mutually exclusive, and as a result practices based on this framework may be counter-productive because their subjectivating effects on girls and women may undermine their broad political aims.

This paper tracks and attempts to unravel a persistently dominant discursive construction of the problem of women's under-representation in science, engineering, and technology (SET) education and work: the idea that the interaction of gender stereotyping with the masculine image of SET disciplines and workplaces prevents girls and women from choosing SET subjects and going into SET careers. Feminists writing on this topic (see for example Henwood 1996 and 1998; Hughes, 2001; Volman *et al.*, 2001) have argued that despite the existence of a body of work which engages with the complex co-construction of gender and SET, the issue of women's participation in SET has since the 1970s been positioned in the mainstream within a liberal-feminist politics which leaves the 'black boxes' of gender and SET (Henwood and Miller, 2001) untouched and advocates changing women's dispositions and perceptions in order that they might choose, and fit better into, SET. Since the mid-1970s a field of activist and pedagogic activity around the issue of 'Women in SET' has emerged in the UK, beginning with initiatives focused on improving girls' experiences of, and

achievements in, science and technology subjects at school (Weiner, 1994; Arnot *et al.*, 1999), and growing into a collection of activist groups and educational projects with links to similar activity in mainland Europe, North America, and further afield (Phipps, 2005). This paper will examine the 'Women in SET' discursive framework as it operates in this field, at macro and micro levels.

Henwood (1998: 46) has argued that equal opportunities politics for women in SET constitutes '[an] attempt to "get women in" [to SET] without upsetting the gender order'. This paper will develop her argument further by showing that the 'Women in SET' discourse actually reinforces traditional and essentialist notions of gender, many of which are implicated in the symbolic incompatibility of women and SET. In other words, in addition to political critiques of the inability of equal opportunities politics to tackle structures of gendered disadvantage (Henwood, 1996; Hughes, 2001; Arnot, 2002), there is a theoretical issue in that the conceptual underpinnings of the 'Women in SET' discourse undermine its broad message about women's equality in SET. Although it is beyond the scope of this paper to do more than speculate about the impact of this, the relative lack of progress made during the past thirty years in terms of promoting women's participation in SET (see for example Gilbert, 2001; Institute for Employment Research, 2003) suggests that such a discourse is inadequate as the basis of a successful political strategy.

## **Methodology and theoretical framework**

The research on which this paper draws was conducted between 2001 and 2005, and included a mapping of a section of the field of activity around 'Women in SET' in Europe and North America and analysis of its discursive framings at macro and micro levels. The research identified four major policy/funding agencies, over 300 activist groups, almost 400 educational projects, and approximately 20,000 individuals active in the field. For the macro-level discourse analysis, print and web documentation was examined and two online questionnaires were distributed. The documentation included policy reports and articles<sup>1</sup>, good practice guides, and publicity material for activist groups and educational projects. The first online questionnaire was a general call for information targeted at individuals active in the field, and the second was a more focused instrument targeted at the coordinators of particular projects. Both questionnaires were publicised via web pages, Email lists, and snowballing through various groups of contacts. 280 responses were received in total, on behalf of 180 individuals and 100 projects. This collection of respondents was self-selecting, and should therefore be assumed to be indicative rather than representative of the field at large.

The micro-level discourse analysis was conducted through in-depth, semi-structured interviews with a sample of 16 'Women in SET' activists. These activists were or had previously been involved in a variety of activities, including membership organisations to support and represent women scientists,

educational projects for schoolgirls and women, and policymaking and political lobbying. They were located in both Europe and North America, had been involved in the field for varying lengths of time, and were largely employed in natural science and technical professions (although four were social scientists). All the women were white and should probably be described as middle class. Some pertinent details about the sample are presented in Figure 1 below.

The sample was not large enough to be representative of the field of activity in general. However, it was broad enough to be indicative, and the interview findings were triangulated with the responses to the two web-based questionnaires and the print/web documentation.

Foucault’s concept of discourse will be used in this paper in order to imagine the ‘Women in SET’ framework as a collection of ideas and meanings and also as a structure which prescribes and prohibits various different activist and educational practices and makes available certain subject positions whilst closing down the possibility of others (Ball, 1990; Henwood, 1998; Mills, 2003). The underlying assumptions of the ‘Women in SET’ framework will be examined in the context of Foucault’s theorisation of the interaction between knowledge, power, and practice (see for example Foucault, 1977) and the co-production of knowledge, power, and the subject (see for example Foucault, 1979). The conclusion will make some suggestions about the possible implications of how the ‘Women in SET’ framework is structured, raising fruitful questions for further research on the practices being developed in the field and the conditions of possibility these create for the production of bodies, subjectivities, and educational and gendered identities.

### The field’s discursive framings

The macro-level mapping of the discursive framings of the field showed that activism and educational projects based on ‘Women in SET’ discourse largely

Pseudonym	Country/region	Profession	Approx. duration of involvement in field
Elaine	Canada	Engineer	5 years
Sandra	Canada	Engineer	5 years
Sarah	Canada	Engineer	5 years
Laura	Europe	Biologist	5 years
Susan	Europe	Social Scientist	20 years
Abigail	Europe (UK)	Chemist	30 years
Barbara	Europe (UK)	Social Scientist	20 years
Jane	Europe (UK)	Biologist	10 years
Jean	Europe (UK)	Engineer	10 years
Jenny	Europe (UK)	Social Scientist	10 years
Margaret	Europe (UK)	Physicist	30 years
Pam	Europe (UK)	Chemist	30 years (now deceased)
Rita	Europe (UK)	Biologist	10 years
Fiona	US	Computer Scientist	20 years
Hannah	US	Computer Scientist	10 years
Rachel	US	Social Scientist	10 years

Figure 1 Interviewees

focus on changing girls' and women's dispositions and perceptions in order for them to have greater access to SET subjects and professions and to cope better in classrooms and workplaces. The primary demand seemed to be for the inclusion of girls and women in SET, rather than a challenge to the cultural masculinities of SET classrooms and workplaces and the symbolic intertwining of SET and hegemonic masculinity (Lohan and Faulkner, 2004). The two most common themes of activist work were the promotion of women's participation in SET through awareness-raising and educational activities and support and assistance for women already participating in SET to enable them to cope with male-dominated environments.

For instance, the UK Association for Women in Science and Engineering (AWiSE) is a non-profit membership organisation founded in 1994 which aims 'to advance the participation of girls and women in the sciences' and which has 13 branches and approximately 500 members (AWiSE, 2004). The organisation sponsors mentoring and networking activities for women in scientific professions and educational activities that focus on stimulating girls' interest in the sciences. It also publishes a magazine to keep its members up to date with the work of other activist groups and policy developments as well as personal stories of women who have been successful in science (AWiSE, 2004). The US Association for Women in Science (AWIS) publishes a magazine which contains similar content (although *AWIS Magazine* also contains articles on recent scientific research undertaken by women and occasionally psychological and sociological research on the problem of 'Women in SET'). AWIS is a non-profit membership organisation, set up in 1971, which has over 5000 members and 76 local chapters (AWIS, 2004a, 2004b, 2004c). Its aims are 'to achiev[e] equity and full participation for women in science, mathematics, engineering and technology' and its activities include facilitating networking and mentoring among women scientists, developing educational projects to interest girls and young women in the sciences, and participating in policy dialogue at federal and state level (AWIS, 2004b).

Of the 180 respondents to the general questionnaire, half were from the US. The remainder were divided between the UK, Australasia and mainland Europe, with isolated responses from Botswana, Brazil, Thailand, The Gambia, Trinidad and Tobago, and Uganda. However, despite the diversity of the sample, there was a certain homogeneity apparent in their constructions of the problem of 'Women in SET' and possible solutions. Notions such as stereotyping and sex-role socialisation were prominent, and respondents made reference to a lack of role models/lack of encouragement for girls in SET, a lack of information about scientific and technical careers, a macho image of SET and SET organisations, and gendered childhood experiences; for instance the idea that 'boy play is directed toward technology, [and] girl play is directed toward housework and parenting' (Respondent 54, Maine, USA). Many of the respondents also felt that girls and women lacked confidence, and some made reference to a difficulty on the part of girls and women with tackling so-called 'hard science' subjects such as physics and maths. The following quotes from survey respon-

dents are indicative of the general tone and content of the answers to the question, *What do you see as the main reasons for girls'/women's lack of participation in science/engineering/technology education and/or careers?*

Lack of examples in public life of women scientists; nerdy images of male scientists which are off-putting to girls at a time when they are trying to get to grips with becoming 'feminine' in the teenage years; need to tackle 'difficult' hard science subjects such as physics and maths (Respondent 10, UK).

The lack of people focus of these areas: they focus on 'facts' rather than social context or involvement. People-oriented aspects of science tend to be looked down upon as 'soft' and seen as 'women's issues' rather than 'people issues' (Respondent 15, Australia).

The lack of participation in the education is the negative image science has in society. Also the lack of female role models plays an important role. Being an engineer is still considered to be a men's job and perhaps girls are afraid to enter that male society (Respondent 25, Belgium).

I see the reasons to be lack of encouragement and lack of resources and information at many girls disposal. It seems as though at a young age, girls are told that it is okay to not like math and science. It is accepted because there are other disciplines that would be 'better'. Also, girls are simply not getting the information that they need to pursue a possible dream of theirs. No one is giving them the facts and figures about women in science, math, engineering, and technology. We need our voice to become heard before girls will take interest (Respondent 84, USA).

Women are inhibited by a lack of role models who balance family and Physical Science, Technology, Engineering, and Math (PSTEM) careers, positive experiences in PSTEM activities that interest them, and a competitive system that neglects their need for building confidence and balancing career goals with other life goals (Respondent 105, USA).

Of the 100 educational projects that were accessed through the second online questionnaire, more than half were located in the US. Of the remainder, half were located in the UK, and the other half were split between Canada, Australia, and mainland Europe. The projects were all underpinned by a similar discourse, largely focused on stimulating girls' interest in science and technology through hands-on learning techniques and operating under the assumption that girls have negative experiences and perceptions of SET subjects and careers. Many of the projects aimed to expose girls to science and technology in a way that would appeal to their interests, which were defined as being bound up with the social and human applications of SET. Role modeling strategies were also prominent, and were often combined with careers advice: the subtext here was that girls and young women have mistakenly

negative perceptions of careers in SET fields and there is a need to make them aware of the fact that there are valuable opportunities available to them. Of the 100 projects, 3 were targeted at university-level women and above: these focused on mentoring and support, being built on the idea that women in SET need to be trained to develop coping mechanisms to facilitate their participation in SET workplaces. The examples in Figure 2 below are indicative of the types of project descriptions that were provided.

Project No.	Description
2 (USA)	A one-day conference held annually for approximately 300 middle school (6-8th grades) girls. Each student attends three career sessions as well as the opening session and closing activity. Middle school girls come to the conferences to learn about the wide range of career options for women in science, engineering and math. Through hands-on workshops and visits to work places, they find out what it's like to work in different careers. Student participants have a chance to interact with professional women who work in a variety of fields. And they have a chance to meet other girls who share their interests.
34 (USA)	This multifaceted program engages teachers, counselors, families, role models and peer networks to keep girls involved and motivated in technology. The program comes at a critical time in girls' development, building bridges to ease the transition from middle school to high school and to help girls visualize the next steps to college and careers. Project goals include: (1) encouraging girls to pursue academic and career options in technology and (2) contributing much needed research regarding gender, culture and technology.
47 (UK)	An initiative aimed at sixth form girls that are studying Maths and Physics at A level / Scottish Higher. Those selected from applications attend a UK University for a week with approx 40 others, they have the opportunity to carry out practical hands on activities, attend talks, work on silly challenges in teams, socialise and meet working female engineers. They also visit an engineering company for a day, usually different companies in small groups.
50 (Canada)	The initiative consists of day long conferences geared towards girls in Grades 9 and 10. The students take part in hands-on workshops led by women Role Models in science and tech careers. They also hear from a dynamic, enthusiastic keynote speaker and have a chance to network one on one with the Role Models during lunch. Often held at a local post secondary school, the girls have a chance to explore the facilities and get info about the programs the university/college has to offer. Door prize draws round out the day.
80 (UK)	Targets female school students from aged 12 to 17. Aims to redress the gender balance and attract girls into SET subjects. Consists of three sections: <ul style="list-style-type: none"> <li>- Mission Impossible - aimed at 12-14 years - carousel of practical challenges. Introduces the idea of girls as engineers, engineering as fun and relates to school work as well as to careers</li> <li>- Conference - aimed at 14 to 16 yrs - Role Model speakers, practical workshops and a career fair. Attempts to inform prior to A level subject choices.</li> <li>- Insight Into Engineering - from 16 - 18 years. A day in University looking at departments and courses and listening to role model speakers with two days in between of placement in industry. Aims to inform University course choice.</li> </ul>
98 (USA)	A program designed to inspire middle and high school girls to seek education and careers in science, engineering, math and technology fields (SEMT). The program consists of after-school science clubs for girls, led by female mentors, meeting weekly to do hands-on science and math activities, build self-esteem and confidence in SEMT abilities, and includes site visits to see women at work in the sciences.

**Figure 2** *Examples of 'Women in SET' projects*

## **'I'm not saying talk about ironing – but it's that sort of thing': exploring the 'Women in SET' discourse**

The macro-level mapping research presented above has summarised some of the main elements of 'Women in SET' discourse as it operates in the contemporary field of activity. Along with Henwood (1996), I would argue that there is a need to deconstruct such dominant discursive frameworks, in order to understand on a deeper level how they operate, or 'the enunciations required and those forbidden' (Foucault, 1979: 100). Only by doing this can we see how such frameworks structure and limit the spaces and ways in which politics can be enacted and identities articulated. The second part of this paper will attempt to engage in such a deconstruction, exploring the 'Women in SET' discourse via data from interviews with 16 activists. It should be noted that a small number of activists drew on alternative discursive frameworks, but in order to sustain a strong focus for this paper, only the dominant 'Women in SET' framework will be examined. In other work (see Phipps, 2005; Phipps, 2006) I have explored alternative frameworks and made suggestions about why they were so sparsely apparent in the interview discussions.

In their constructions of the problem of women's under-representation in SET, many of the activists drew on versions of socialisation theory, or ideas about how children are slotted into sex roles from the moment of birth which construct their interests and educational/career preferences in stereotypical ways. Jane, a prominent biologist and senior officer of one of the UK's foremost activist groups for women scientists, referred to 'early indoctrination' in the form of the stereotyped images young children are exposed to, arguing that since the scientist is always male (for instance, in popular culture representations and/or school textbooks), girls internalise the message that scientific careers are not appropriate for them. Other interviewees made similar points: for instance, Hannah, the president of one of the local chapters of a major US association for women in computing, made reference to the gendered toys that children play with and their function in sex-role socialisation, or the idea that girls are given feminine toys such as dolls and cookery sets and boys are given masculine toys such as trucks and construction kits, which structures their educational interests and eventually their career choices. Hannah mentioned that she had given her own daughter 'analytical' toys, and implied that this had had an influence on her daughter's choice of science as a career.

Socialisation theory, Walkerdine (1988) argues, is a theory of female lack which constructs girls and women as passive objects rather than active subjects in relation to social norms and expectations. A construction of girls as essentially passive was implied in the activists' assumption that girls' lives would be inescapably structured by the toys they were given and the representations they were exposed to in popular culture and education, and that they would uncritically and even unconsciously follow social stereotypes when making educational and career choices. Jane's use of the word 'indoctrination' implies

a female subject who serves as a blank slate on which normative femininities can be inscribed. The activists' statements also showed a tendency to homogenise masculinity and femininity, to construct sex as synonymous with gender, and therefore to imagine that girls would have a straightforward relationship to femininity, and boys to masculinity (cf Henwood, 1996). Rita, an extremely high-profile activist who has been involved in policymaking in the UK, went further to position women as being at the mercy of their biology, stating that women students could under-achieve if forced to take exams while they were menstruating. This statement evoked Victorian (and even ancient Greco-Roman) notions of the womb as an impediment to rational thought (Ehrenreich and English, 1979), and stands as an extreme example of the tendency of such discursive frameworks to 'pathologize girls and normalize masculinity' (Walkerdine, 1998: 160).

Further to this, the idea of female lack was explicitly mobilised by many of the interviewees, through references to girls' and women's supposed lack of confidence and lack of awareness of educational and career opportunities in SET. For example, Hannah felt that women are socialised to 'lack confidence, whereas men *expect* to be included', and saw girls as being caught up in a counter-culture focused on fashion and beauty and lacking in awareness of the need to achieve and support themselves in adulthood. Margaret, a UK-based activist who had been involved in educational projects for girls and young women, felt that girls 'don't put [themselves] forward', and 'often don't think of doing [SET] jobs.' Elaine, the president of a major local chapter of a Canadian activist group, felt that as a result of what she termed intimidation in high school, 'women tend to think of engineering as "oh, that would be hard," and they sort of self-select [out of it]'. Girls and women, then, were seen as lacking in confidence and imagination, as well as being at the mercy of their parents, teachers, peers, society, and their biology. These constructions of female passivity and insecurity appear to undermine the broader political message about women being as capable as men in science, engineering, and technology, and also take little account of the fact that feminine subject positions may allow girls and women to express their insecurities more easily than boys and men, which does not mean that their levels of insecurity are necessarily higher (Woodfield *et al.*, 2005).

In a previous study of women engineers in the UK (Phipps, 2002), the image of engineering rather than factors such as the male domination (numerical and structural) of SET, the assorted cultural masculinities of SET classrooms and workplaces, and the symbolic intertwining of SET and hegemonic masculinity (Lohan and Faulkner, 2004), was most commonly cited as the cause of women's under-representation. This focus on image was echoed in the current study, and reflects the fact that within the discursive framework of 'Women in SET', the problem of women's under-representation in SET is a result of how women's socialised femininity comes into conflict with the masculine image of SET subjects (Henwood, 1996). Two prominent (and familiar) symbolic representations of SET for the activists were the male technician with dirty hands

(cf Henwood, 1996) and the elderly male lab-based academic who is socially incompetent and only comfortable in the realms of abstraction. In addition to this, Hannah made reference to the image of the young male geek who is socially incompetent and usually confined to his bedroom (cf Lupton, 1995), and Fiona, the director of a US-based agency concerned with promoting the participation of women in computing, referred to the rather more culturally credible image of the genius-like hacker (who can be compared to the masculine mathematical genius in Mendick, 2005). Images such as these were thought to be a deterrent to girls and young women who would be unable to identify with them; however, there was no analysis of how the negotiated production of femininities could be substantively shaped by symbolic representations such as these (see for example Mendick, 2005). Instead, it was argued that SET needed, in Laura's words, an 'image change', and that girls and women needed to shake off their misunderstandings and become aware of the true nature of SET.

In her 1996 study of the WISE Campaign, Henwood similarly found constant reference being made to 'the popular image of engineering as "dirty, heavy work" or, more generally, as "masculine", which is then presented as a "misconception" on the part of women and hastily dismissed' (Henwood, 1996: 203). The activists in this study were equally careful to distinguish between girls' and women's perceptions of SET and its apparent reality as humanistic, cooperative and active (and therefore compatible with socialised femininity). In the following quote from Rachel, the director of a high-profile US organisation which represents women scientists, she constructs science as a social, caring, and collaborative enterprise and implies that an image change could be created accordingly.

A lot of women say 'I want to do a job, I want to have an impact on society, I want to make a difference to this world.' And we don't translate well, 'if you care about the environment, if you care about society, then let's talk about what you can be doing with nanotechnology, or let's talk about what's happening in biochemistry right now.' I think unfortunately students tend to think, 'I can't do these things because I like to be with people, and scientists are always on their own,' which is actually not the case, since most scientists tend to work in teams.

However, such constructions tend to disregard the body of evidence attesting to the assorted masculine cultures and epistemologies of SET fields (see for example Cockburn, 1983 and 1985; Carter and Kirkup, 1990; Ginzberg, 1989), and the deep symbolic intertwining of SET and masculinity (see for example Walkerdine, 1988; Hughes, 2001). This suggests that attempts such as Rachel's to feminise the image of SET is based on a misunderstanding of the problem, since girls and women may not in fact be labouring under a delusion that SET is associated with masculinity(ies) and may in fact be justified in their perceptions (Henwood, 1996: 203).

Many of the activists felt that presenting a more feminine image of SET was the best way in which to increase women's participation. The use of successful female SET professionals as role models was commonly cited as a good strategy by which to change girls' perceptions of SET fields as masculine and to present SET disciplines as fun and even fashionable. Rachel, for instance, described an initiative she felt had been particularly successful, due to the fact that the role model involved, a female researcher from the national zoo, was 'young and cool'.

She had a microscope, and she was young – she was cool. The whole way – the way she dressed, the way she acted . . . her name was Annie, and the study she was doing was on white tigers. And these girls . . . I'm not exaggerating, at lunchtime, some of them came up to her and gave her a pencil and said 'what is the name of your job? I want to know, because that's what I want to do.' And it was like, they were so excited! So part of it is just helping these girls, and their parents, to understand that there are people they can relate to and emulate.

Rachel's statement above constructs girls and their families as ignorant of opportunities in SET fields, and reiterates the idea that it is 'only a misunderstanding of girls themselves that they do not like science, engineering, and technology' (Volman *et al.*, 1995: 290). In addition, and despite the girls' enthusiasm in this particular example, there are questions concerning the long-term success of role model initiatives when taking into account the various structural, cultural, epistemological, and symbolic barriers to women's participation in SET.

An interesting outcome of the idea of female lack that underpins such discursive frameworks can be seen in Margaret's reference to a role model initiative that had not been successful: the responsibility for this failure was located with the girls themselves, who were constructed as being unable to identify with the role model.

We got one of the first women who had ever worked in the Antarctic to come and talk. And [the girls] thought it was fascinating, but they couldn't imagine themselves ever being there. And this sort of caught us unawares, that someone was showing them how exciting it was, and the photographs were wonderful . . . but they didn't imagine themselves able to do it. And I wonder how deep that is in other areas, that the thought of taking off at 15 to the Antarctic wasn't something they could imagine.

This devolution of responsibility onto the girls, rather than critically assessing the role model strategy itself, uncovers a conceptual circularity at the heart of the 'Women in SET' framework. Because its model of the problem is one of female lack, the framework is set up to reproach girls and women who do not respond to the strategies developed for their benefit, since their perceptions

are seen as misunderstandings and their preferences a result of ignorance. Thus, the validity of the discourse as an explanation and a source of solutions is preserved.

Ideas about feminising SET were also apparent in discussions about reforming curricula to include the social and human aspects of SET disciplines. For instance, Fiona felt that girls and women would be attracted by more 'people-oriented' approaches to science and technology, because 'girls like to be doing things that have a benefit to society, or that have an application to the world.' Along the same lines, Hannah argued that women function biologically to 'give and care for society', and therefore would be interested in the applications of SET which correspond with this function. Jean, a ten-year member of a long-established UK organisation for women engineers, felt that using more feminine examples in the science curriculum would appeal to girls' interests and help them to relate better to the material.

If you use the example of physics – imagine a train going at this speed down an incline – you need to use a more feminine example that girls would relate to better, to actually prove the same point. And I think too many of the models are trains and cars and euphemisms for speed – as opposed to something that a girl would find more interesting. I'm not saying talk about ironing – but it's that sort of thing.

As well as assuming that girls have an uncomplicated relationship to femininity, these statements by the activists constructed boys as synonymous with technical and girls as synonymous with social interests and pursuits. This can be seen in the following quote from Abigail, a veteran activist who in the 1970s had founded an international organisation, focused on networking and knowledge exchange, which continues to operate today.

Girls [will] be involved with problem-solving, if it's related to things that they see as problematic. My girls and technology education project showed this – we analysed the entries to three years of the Design Prize competition . . . fourteen year olds. And it was very interesting; the things they developed were very similar, boys and girls, but the thing that differed was their definition of the problem they were investigating. The boys were investigating a technical problem – the girls were seeking a solution to a social problem.

Associated with these dichotomies between girls/boys, femininity/masculinity, and social/technical is the equivalence between boys, masculinity, and technical skill that has been highlighted in research on women's exclusion from SET fields (see for example Cockburn, 1983 and 1985; Connell, 1987; Paechter and Head, 1996). In addition, the construction of girls and women as naturally more social and caring has been criticised for its essentialism and unquestion-

ing valorisation of feminine characteristics that have been learned in a context of unequal power relations between women and men (Dietz, 1985; Boling, 1991). In the interviews however, such notions were mobilised without reference to the possible risk of reiterating gendered hierarchies through emphasising gender differences.

A number of the activists mobilised a gendered binary between abstraction and application, stating that girls are not comfortable with abstract and mathematical thinking and prefer to engage in a more hands-on way with the applications of SET. For instance, Elaine felt that 'women really like to have examples and applications, like where are you going to apply this – outside the hardcore theory of it', and her use of the term 'hardcore', which has sexual connotations and evokes a male subject who finds theorising pleasurable, also implies a hard/soft binary which has gendered underpinnings. Jean similarly felt that in electronic engineering, 'the requirements for extremely logical thinking and a very high degree of maths ability in some quite challenging areas of maths [are] a deterrent to lots of girls'. Jean's statement was heavily underlined with the idea of female lack, and the binaries implied between boys/girls, really good at maths/not (or fairly) good at maths, very logical/illogical (or fairly logical), and confident/insecure echo Heather Mendick's (2005) research uncovering similar binaries in the context of young people's relationships with mathematics. Mendick draws on Walkerdine's (1988, 1998) argument that the cultural construction of girls, women and femininity precludes notions of rationality and logical thinking, and contends that the 'gendered oppositional inscription of mathematics' makes it difficult for young women to conceptualise themselves as 'good at maths' (Mendick, 2005: 217).

Walkerdine also argues that popular constructions of girls as 'hard-working, rule-following, [and] not brilliant' have been apparent 'in all aspects of classroom practices and in the truths produced about gendered attainment' (Walkerdine, 1998: 158). These constructions feed in to the 'fiction of female failure and lack, and of male success and mastery, against which girls struggle' (Walkerdine, 1998: 158). Such constructions of girls and women were apparent in the interviews with the activists. Rita stated that 'women [undergraduates] are very conscientious and like to read around the topic, whereas men will revise one or two questions and hope they come up in the exam', putting this forward as an explanation for why men tend to get more first- and third-class degrees, while women get more upper second-class degrees. Similarly, Jean rejected the device of traditional, exam-based assessment at both school and university due to her construction of girls as more conscientious and therefore more suited to coursework. This was underpinned by an idea of girls' natural caution and boys' natural adventurousness:

Girls tend to be very conscientious – work diligently through the year. And therefore where they get more opportunities to submit coursework they

will get a higher average score. Boys naturally respond to the adrenalin of an exam situation better.

These explanations of academic achievement with reference to gendered personal characteristics did not show an awareness of academic research around the role of teaching and assessment practices in constructing such differences in achievement (Richardson and Woodley, 2003), or research which has challenged the simplistic formulation that all female students prefer coursework and all male students prefer exams (Woodfield *et al.*, 2005). These explanations were also consistent with the general tendency of the activists to characterise gender in decontextualised, ahistorical, and essentialist ways.

## Conclusion

‘Women in SET’ discourse has voluntaristic and individualistic underpinnings (Henwood, 1996 and 1998), being based on notions of access and choice. It is argued that girls and women opt out of educational and career opportunities in SET because the masculine image of these fields conflicts with prevailing stereotypes of femininity. This ‘gender deficit’ model (Arnot *et al.*, 1999: 74) locates the causes of girls’ and women’s under-representation in SET in girls and women themselves. However, this is not based on any meaningful model of agency, since the theoretical framework is supplied by socialisation theory, which posits that children and young people are slotted in to predetermined sex roles throughout their educational and social lives. As a result, it is argued, they develop sex-specific skills and interests, which drive girls away from science and technology fields.

The discourse situates SET as gender-neutral, and asks: ‘since men and women are equals, what are the barriers which keep women out of [SET], and how can they be removed so that women can join (a presumed gender-neutral activity) on the same grounds as men?’ (Kirkup and Keller, 1992: 9). Its construction of gender embodies a tension between sameness and difference: women’s similarity to men (eg their equal capability in SET) is used as an argument for equality, but the characterisation of girls and women which underpins the discourse is derived from normative constructions of gender difference. Overall, as Bacchi (1990) has argued, neither sameness or difference is a satisfactory basis for political action, since both principles take men as the benchmark by which women are measured, and neither takes into account the diversity of human positionings and needs. It is also true to say that difference should not necessarily be seen as incompatible with equality (Bacchi, 1990). However, the construction of gender difference within ‘Women in SET’ discourse warrants further analysis, as these particular characterisations of girls and women may in fact be antithetical to their equality in SET.

‘Women in SET’ discourse is based on a binary between femininity and masculinity in which women are domestic, passive, and emotional while men

GIRLS/WOMEN	BOYS/MEN
feminine	masculine
social	technical
identified with home (private)	identified with work (public)
soft	hard
interested in applications	interested in abstractions
conscientious	brilliant
insecure	confident
cautious	adventurous
fearful	brave
compliant	independent
unable to deal with difficulties	able to deal with difficulties
collaborative	competitive
illogical	logical
not very good at maths	good at maths
ignorant of opportunities	[aware of opportunities]
in need of support	[not in need of support]
in need of encouragement	[not in need of encouragement]
misguided in their perceptions	[accurate in their perceptions]
frivolous	[serious]
lacking in imagination	[imaginative]
malleable	[fixed]
passive	[active]
biologically governed (body)	[able to escape biology (mind)]
(pathological)	[normal]

**Figure 3** Deconstructing ‘Women in SET’ discourse

are rational, individualistic, competitive, confident, and technically skilled (Keller, 1992; Connell, 2002). It reinforces the gendered distinction between public and private spheres, with men associated with the public world of work and women associated with the home. It is also deeply implicated in the heterosexual binary, or the idea that there are two sexes upon which two genders can be straightforwardly mapped in opposition to one another. Despite this, initiatives based on ‘Women in SET’ discourse purport to liberate girls and women from gender stereotypes. Figure 3 above represents some of the binaries that underpin ‘Women in SET’ discourse. This analysis is constructed in a similar way to Francis and Archer’s (2005: 517) deconstruction of the categories of ‘lad’ and ‘British-Chinese (boy)’; as in their analysis, brackets contain the binaries that were implied rather than overtly apparent in the data.

Such gendered constructions evoke Victorian value systems which incorporated a distinction between men and women situating women as incapable of scientific thought: men were associated with reason and intellect while women were associated with nature and emotion, and men were positioned in the public world of politics and science while women’s proper place was seen as the home (Harding, 1992; Arnot, 2002: 186). The positioning of girls/women as illogical, not good at maths, and interested in applications rather than abstractions is diametrically opposed to popular Western constructions of science and

technology as synonymous with abstract rationality (Faulkner, 2001; Gilbert, 2001; Hughes, 2001). The construction of girls/women as conscientious and boys/men as brilliant implicitly identifies boys/men with science due to the association of brilliance and scientific knowledge in the symbolic imaginary (Hughes, 2001: 281). Science was identified by many of the activists participating in this study as a difficult subject, consistent with popular characterisations (Hughes, 2001), and there was an accompanying construction of girls/women as being unable to deal with difficulties. Similarly, girls/women were characterised as compliant, in need of support and encouragement, and lacking in imagination, while the scientist has been popularly represented as independent and/or autonomous (Gilbert, 2001). The implicit construction of girls/women as governed by their biology is in conflict with widespread ideas about technology being bound up with control over nature (Faulkner, 2001). The binary between soft and hard which is associated with girls/women and boys/men respectively relegates girls and women to the sidelines in terms of the popular assumption that hard science and technology subjects are somehow real science and technology (Faulkner, 2001).

It is difficult to do more than speculate about why 'Women in SET' discourse, while located in the liberal feminist tradition (which has traditionally emphasised women's similarity to men and attempted to degender the public sphere) and claiming to work against gender stereotypes, incorporates such conservative and essentialist constructions of gender difference. One possibility is that this reflects the impact of the 'difference' strand of feminism which began to emerge in the postwar period (Bacchi, 1990, see also Gilligan 1982; Boling 1991; Ruddick 1992 for examples) and which emphasised women's qualities of nurturance and caring as the basis of politics and social transformation. However, this is perhaps unlikely: I have shown examples in other work of how the SET professionals who make up the majority of 'Women in SET' activists have little interest or grounding in the canon of feminist theory (Phipps, 2006). It could also be suggested that these persistent notions of gender difference merely illustrate the patriarchal nature of the liberal tradition itself, which incorporates a construction of women as not only different but a threat to democracy (see for example Pateman, 1989). Over and above this however, it is possible to examine more deeply the context in which 'Women in SET' discourse is deployed, to find other potential influences on how it is constructed.

On a general contextual level, it could be suggested that 'Women in SET' discourse is reflective of the broad political context in which it is deployed and influenced by Thatcherite and neo-conservative ideas about natural differences between the sexes (Arnot, 2002). Bacchi (1990) argues that feminists have used arguments from sameness and difference at particular social moments and with particular goals in mind: the emphasis on gender difference here could perhaps be seen in terms of a context in which the right-wing backlash and ideas about the 'crisis of masculinity' make it difficult to put forward arguments which challenge the gender order. On a more specific level,

there may be a link between the structure of 'Women in SET' discourse and the scientific epistemologies within which many of the activists work, science itself being highly dualistically based (see Harding, 1992; Faulkner, 2000). In other work I have also explored efforts made by 'Women in SET' activists to preserve their femininities while situated in traditionally male disciplines and making politically sensitive arguments about women's equality (Phipps, 2006). It is possible to make a connection between this and the gender conservatism underpinning 'Women in SET' discourse, both in terms of individual identity work and more conscious political strategies.

It is not possible within the parameters of this research to do more than speculate about the practices following from 'Women in SET' discourse and the subject positions these may enable and exclude. However, it does seem that the discourse may confirm rather than challenge the 'unassailable presence' (Nayak and Kehily, 2006: 470) of traditional gender values within mainstream education. Educational initiatives based on the 'Women in SET' framework are concerned with developing 'girl-friendly science' (Weiner, 1994), or creating an image of science and technology compatible with socialised femininity. This involves stressing the social and human aspects of scientific and technical practice and discussing applications of science and technology in areas such as the home, the human body, health and the environment. At the very least it can be (and has been) said that such approaches do not engage critically enough with the discipline of SET, being focused on altering its presentation on a superficial level rather than examining its epistemologies and practices.

Further to this, and considering the 'subjectivating effects of discourse' (Youdell, 2006: 513, see also Butler 1990, 1993, 1997 and 2004), the analysis presented in this paper suggests that initiatives based on the 'Women in SET' discourse may constitute normative feminine subject positions which are incompatible with popular constructions of SET. If education provides the conditions of possibility within which appropriate (gendered, raced, classed, sexualised, embodied) subjects are constituted (Davies, 2006), curriculum and pedagogy are two of the most important frameworks within the web of discourses (Youdell, 2006: 524) through which students understand themselves and what they are to become. While purporting to liberate girls and women from gender stereotypes and promoting their equality in SET, initiatives which mobilise 'Women in SET' discourse may actually be engaged in processes of regulation which reinforce those stereotypes and construct girls/women and SET in such a way as to make it difficult for girls and women to understand themselves as being capable SET students and future professionals.

It is difficult to envisage how such an established discourse can be contested, particularly in terms of the challenges presented to activists by the broad context of the New Right backlash and the specific contexts of the disciplines of SET. Ideally, there could be more cross-pollination between 'Women in SET' activists and feminists working in science and technology studies, who have developed analytical frameworks focusing on how gender

and SET are constructed in relations of mutual dependence through which activists could critically appraise their languages and activities (see for example Harding, 1986; Fox Keller and Longino, 1996; Lohan, 2000; Wajcman, 2000; Faulkner, 2001; Henwood and Miller, 2001; and Mayberry, Subramaniam, and Weasel, 2001). In terms of research, micro-level investigations which recognise the intersections between gender and categories such as 'race', class, sexuality, age, and (dis)ability (Renold, 2000; Youdell, 2003 and 2005), particularly within the disciplinary context of SET (see Hughes, 2001 for a rare example of such work), could help to break down the dualisms which underpin 'Women in SET' discourse. Also at the micro level, there are fruitful possibilities for researching 'Women in SET' practices and their subjectivating effects, in order to provide evidence of how the gendered construction of the discourse shapes the experiences and perceptions of girls and women who participate in 'Women in SET' initiatives.

This paper has attempted to track, deconstruct and contextualise the dominant discursive framework within which the issue of 'Women in SET' is positioned. The analysis suggests that the structuring of 'Women in SET' discourse may actually undermine its political aims in reinforcing normative constructions of gender which locate girls and women in an oppositional relationship to SET. Thirty years of efforts to promote women's participation in SET have had mixed results: while girls are outperforming boys in all subjects in compulsory education, gender segregation remains at post-compulsory levels and is even more acute in the workplace (UK Resource Centre for 'Women in SET', 2006). This suggests that there is a need for further critical engagement with 'Women in SET' discourses and practices.

## Acknowledgements

Thanks are due to the following people and organisations: Professor Madeleine Arnot, who supervised the research on which this paper is based; the Economic and Social Research Council of Great Britain and University of Cambridge for research funding; Professors Diane Reay and Flis Henwood and Dr Ruth Woodfield, who gave feedback on earlier versions of this paper; and, the two anonymous referees who gave such helpful comments on the first submitted version.

## Note

- 1 Academic papers were not analysed unless they had a clear practitioner focus, since much of the theoretical discussion of the issue of gender and SET has little or no bearing on the field of activity itself (Phipps, 2005).

## References

- Arnot, M., David, M. and Weiner, G., (1999), *Closing the Gender Gap: Postwar Education and Social Change*, Cambridge: Polity Press.

- Arnot, M., (2002), *Reproducing Gender? Essays on Educational Theory and Feminist Politics*, London: Routledge.
- Association for Women in Science, (2004a), Association for Women in Science Announces Newly Elected Officers, available online at [http://www.awis.org/voice/press/pr\\_newofficers2k4.pdf](http://www.awis.org/voice/press/pr_newofficers2k4.pdf), Washington, DC: Association for Women in Science.
- Association for Women in Science, (2004b), AWIS Network – About AWIS, available online at <http://www.awis.org/network/about.html>, Washington, DC: Association for Women in Science.
- Association for Women in Science, (2004c), Women in Science Organizations, available online at <http://www.awis.org/resource/links.html#womenscience>. Washington, DC: Association for Women in Science.
- Association for Women in Science and Engineering, (AWiSE) (2004), AWiSE website, available online at <http://www.awise.org/>, London: Association for Women in Science and Engineering.
- Bacchi, C.L., (1990), *Same Difference: Feminism and Sexual Difference*, St Leonards: Allen and Unwin.
- Ball, S., (1990), Introducing Monsieur Foucault in Ball, S.J. (ed.), *Foucault and Education: Disciplines and Knowledge*, London: Routledge.
- Boling, P., (1991), The Democratic Potential of Mothering, *Political Theory*, 19 (4), 606–625.
- Butler, J., (1990), *Gender Trouble: Feminism and the Subversion of Identity*, London: Routledge.
- Butler, J., (1993), *Bodies That Matter: On the Discursive Limits of 'Sex'*, London: Routledge.
- Butler, J., (1997), *Excitable Speech: A Politics of the Performative*, London: Routledge.
- Butler, J., (2004), *Undoing Gender*, London: Routledge.
- Carter, R. and Kirkup, G., (1990), *Women in Engineering: A Good Place to Be?* Basingstoke: MacMillan Education Ltd.
- Cockburn, C., (1983), *Brothers: Male Dominance and Technological Change*, London: Pluto Press.
- Cockburn, C., (1985), *Machinery of Dominance: Women, Men, and Technical Know-How*, London: Pluto Press.
- Connell, R.W., (1987), *Gender and Power*, Cambridge: Polity Press.
- Connell, R.W., (2002), *Gender*, Cambridge: Polity Press.
- Davies, B., (2006), Subjectification: the relevance of Butler's analysis for education. *British Journal of Sociology of Education*, 27 (4): 425–438.
- Dietz, M.G., (1985), Citizenship with a Feminist Face: the Problem with Maternal Thinking, *Political Theory*, 13 (1): 19–37.
- Ehrenreich, B. and English, D., (1979), *For Her Own Good: 150 Years of the Experts' Advice to Women*, London: Pluto Press.
- Faulkner, W., (2000), Dualisms, Hierarchies, and Gender in Engineering. *Social Studies of Science*, 30 (5): 759–792.
- Faulkner, W., (2001), The technology question in feminism: a view from feminist technology studies, *Women's Studies International Forum*, 24 (1): 79–95.
- Foucault, M., (1977), *Discipline and Punish: The Birth of the Prison*, St Ives: Allen Lane.
- Foucault, M., (1979), *The Will to Knowledge: the History of Sexuality Volume I*, London: Allen Lane.
- Francis, B. and Archer, L., (2005), Negotiating the dichotomy of Boffin and Triad: British-Chinese pupils' constructions of 'laddism', *The Sociological Review*.
- Gilbert, J., (2001), Science and its 'Other': looking underneath 'woman' and 'science' for new directions in research on gender and science education. *Gender and Education*, 13 (3): 291–305.
- Gilligan, C., (1982), *In a Different Voice: Psychological Theory and Women's Development*, Cambridge, MA: Harvard University Press.
- Ginzberg, R., (1989), Uncovering gynocentric science, in Tuana, N. (ed.), *Feminism and Science*: 69–84. Indiana: Indiana University Press.
- Harding, S., (1986), *The Science Question in Feminism*, Milton Keynes: Open University Press.
- Harding, S., (1992), The Instability of the Analytical Categories of Feminist Theory, in Crowley, H. and Himmelweit, S. (eds), *Feminism and Knowledge*: 338–354. Cambridge: Polity Press.

- Henwood, F., (1996), WISE Choices? Understanding Occupational Decision-making in a Climate of Equal Opportunities for Women in Science and Technology. *Gender and Education*, 8 (2): 199–214.
- Henwood, F., (1998), Engineering Difference: discourses on gender, sexuality and work in a college of technology, *Gender and Education*, 10 (1): 35–49.
- Henwood, F. and Miller, K., (2001), Boxed in or Coming out? On the Treatment of Science, Technology and Gender in Educational Research, *Gender and Education*, 13 (3): 237–242.
- Hughes, G., (2001), Exploring the Availability of Student Scientist Identities within Curriculum Discourse: an anti-essentialist approach to gender-inclusive science, *Gender and Education*, 13 (3): 275–290.
- Institute for Employment Research, (2003), Bulletin: Women in Science, Engineering and Technology, Warwick: University of Warwick.
- Keller, E.F. and Longino, H.E., (1996), *Feminism and Science*, Oxford: Oxford University Press.
- Kirkup, G. and Keller, L.S., (1992), The Nature of Science and Technology, in Kirkup, G. and Keller, L.S. (eds), *Inventing Women: Science, Technology, and Gender*: 5–11. Cambridge: Polity Press.
- Lohan, M., (2000), Constructive Tensions in Feminist Technology Studies. *Social Studies of Science*, 30 (6): 895–916.
- Lohan, M. and Faulkner, W., (2004), Masculinities and Technologies: Some Introductory Remarks, *Men and Masculinities*, 6 (4): 319–329.
- Lupton, D., (1995), The embodied computer/user, in Featherstone, M. and Burrows, R. (eds), *Cyberspace, Bodies, and Cyberpunk: Cultures of Technological Embodiment*, London: Sage.
- Mayberry, M., Subramaniam, B. and Weasel, L.H., (2001), *Feminist Science Studies: A New Generation*, London: Routledge.
- Mendick, H., (2005), A beautiful myth? The gendering of being/doing ‘good at maths’, *Gender and Education*, 17 (2): 203–219.
- Mills, C., (2003), Contesting the Political: Butler and Foucault on Power and Resistance, *The Journal of Political Philosophy*, 11 (3): 253–272.
- Nayak, A. and Kehily, M.J., (2006), Gender undone: subversion, regulation and embodiment in the work of Judith Butler, *British Journal of Sociology of Education*, 27 (4): 459–472.
- Paechter, C. and Head, J., (1996), Gender, Identity, Status and the Body: life in a marginal subject, *Gender and Education*, 8 (1): 21–29.
- Pateman, C., (1989), *The Disorder of Women: Democracy, Feminism, and Political Theory*, Cambridge: Polity Press.
- Phipps, A., (2002), Engineering Women: The ‘Gendering’ of Professional Identities. *International Journal of Engineering Education*, 18 (4): 409–414.
- Phipps, A., (2005), *Women in Science, Engineering, and Technology: Researching the Arena of Activity*, unpublished PhD thesis: University of Cambridge.
- Phipps, A., (2006), ‘I can’t do with whinging women!’ Feminism and the habitus of ‘women in science’ activists, *Women’s Studies International Forum*, 29 (6): 125–135.
- Renold, E., (2000), ‘Coming out’: gender, (hetero)sexuality and the primary school. *Gender and Education*, 12 (3): 309–326.
- Richardson, J.T.E. and Woodley, A., (2003), Another Look at the Role of Age, Gender, and Subject as Predictors of Academic Attainment in Higher Education. *Studies in Higher Education*, 28 (4): 475–493.
- Ruddick, S., (1992), *Maternal Thinking*, London: Women’s Press.
- UK Resource Centre for ‘Women in SET’, (2006), Statistics on ‘Women in SET’, available online at <http://www.setwomenresource.gov.uk>.
- Volman, M. and van Eck, E., (2001), ‘Gender equity and information technology in education: the second decade’, in *Review of Education Research*, 71 (4): 613–634.
- Volman, M., van Eck, E. and Ten Dam, G., (1995), Girls in Science and Technology: the development of a discourse, *Gender and Education*, 7 (3): 283–292.
- Wajcman, J., (2000), Reflections on Gender and Technology Studies: in What State is the Art? *Social Studies of Science*, 30 (3): 447–464.

- Walkerdine, V., (1988), *The Mastery of Reason: Cognitive Development and the Production of Rationality*, London: Routledge.
- Walkerdine, V., (1998), *Counting Girls Out: Girls and Mathematics (new edition)*. London: Falmer Press.
- Weiner, G., (1994), *Feminisms in Education: An Introduction*, Buckingham: Open University Press.
- Woodfield, R., Earl-Novell, S. and Solomon, S., (2005), Gender and mode of assessment at university: should we assume female students are better suited to coursework and males to unseen examinations? *Assessment and Evaluation in Higher Education*, 30 (1): 35–50.
- Youdell, D., (2003), Identity Traps or How Black Students Fail: the interactions between biographical, sub-cultural, and learner identities. *British Journal of Sociology of Education*, 24 (1): 3–20.
- Youdell, D., (2005), Sex-gender-sexuality: how sex, gender, and sexuality constellations are constituted in secondary schools, *Gender and Education*, 17 (3): 249–270.
- Youdell, D., (2006), Subjectivation and performative politics – Butler thinking Althusser and Foucault: intelligibility, agency and the raced-nationed-religined subjects of education, *British Journal of Sociology of Education*, 27 (4): 511–528.